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Sir Joseph Oliffe M.D.
from his sincere friend
J Y Simpson

ACUPRESSURE

ACUPRESSURE

A NEW METHOD OF

ARRESTING SURGICAL HÆMORRHAGE AND OF ACCELERATING THE HEALING OF WOUNDS

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BY

JAMES Y. SIMPSON, M.D., F.R.S.E.

PROFESSOR OF MEDICINE AND MIDWIFERY IN THE UNIVERSITY OF EDINBURGH,
AND PHYSICIAN-ACCOUCHEUR TO THE QUEEN FOR SCOTLAND;

Formerly President of the Royal College of Physicians, of the Royal Medical, the Royal Physical,
the Medico-Chirurgical, and Obstetric Societies of Edinburgh; Honorary Fellow of the King
and Queen's College of Physicians in Ireland; Laureate of the Imperial Institute of
France; Foreign Member of the Academies of Medicine of France, Belgium, and
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"In Wounds and Operations there are BUT TWO GREAT POINTS to be attended to;—first, the securing the arteries, so that the patient may be in no danger from bleeding; and then the procuring a speedy adhesion, by which the pain, suppuration, waste of substance, and all the other bad consequences of the wound, are prevented."—JOHN BELL'S *Principles of Surgery*, vol. i. p. 41.

561
1864

PREFACE.

ACUPRESSURE, as a new hæmostatic process—founded on the principle of the *temporary metallic compression* of arteries—was first described to the Royal Society of Edinburgh at their meeting on 19th December 1859. An abstract of this communication was published in the "Proceedings" of the Society, vol. iv. (p. 249), and in the "Edinburgh Medical Journal" for January 1860 (p. 645). A few weeks subsequently I sent the histories of the earliest cases of amputation, in which this novel method of arresting surgical hæmorrhage had been employed, to the "London Medical Times" of February 11, 1860.

A year ago I had written nothing additional on the matter, and had no intention whatever of doing so—as the subject seemed to me purely surgical in its character, and hence lay somewhat out of my ordinary walks of study and practice. But in December last I was urged to send to the "Medical Times" one or two lectures on Acupressure. These lectures, when recast for separate publication, have grown into the present formidable volume—at the unforeseen dimensions of which no one can feel more astonished than I am. It has been put together, however, at desultory and disconnected intervals, generally amid the incessant calls and toils of practice, and sometimes when, by sickness and fatigue, I was incapacitated for any other professional work; and I regret greatly that I have had no leisure to shorten and abridge what was written. I must plead the same excuse for any repetitions or other blemishes which the critical reader may possibly detect in the volume. Of these and of its other many imperfections no one can be more sensible than I myself am.

As the different portions of the work have, for the reasons stated, been printed irregularly and intermittingly, one or two parts will be found separated which ought more properly to have been conjoined. I am especially anxious, for instance, that the reader should peruse the first part of Chapter XVIII. after Chapter VI., as they both refer to the best and simplest methods of using Acupressure.

Had it been deemed right or requisite, and had space permitted, it would have been easy to have added to the number of illustrative cases detailed and adduced. For latterly, in addition to numerous instances in our own country, I have been furnished with interesting examples of the successful application of Acupressure from various regions of the world—from America, Australia, and Asia. As the last sheets of the work were printing, Dr. Handyside showed me a letter from that accomplished Medical Missionary, Dr. Davidson of Antananarivo, Surgeon to the Royal Court of Madagascar, speaking of his use of Acupressure in amputation, and adding, "I think I shall never use ligatures again."

I cannot conclude this Preface without heartily thanking my very kind and able assistant and friend, Dr. Black, for all the trouble which he has taken in aiding and abetting me in the study of the literature of the subject, and in assiduously superintending the passage of the work through the press.

EDINBURGH, 21*st November* 1864.

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ON ACUPRESSURE.

CHAPTER I.

Importance of Surgical Hæmorrhage and Surgical Hæmostatics.

Among the great doctrines of surgery, the study of surgical hæmorrhage, and of the best means of arresting it, has always—in ancient as well as in modern times—stood forth as a subject of the foremost importance.

Indeed till a comparatively làte period in the history of surgery, the flow of blood from the vessels laid open in surgical wounds and operations formed a ceaseless source of anxiety and alarm to the surgical practitioner. For he had at his command no sure and simple mode of arresting the discharge. The dread of hæmorrhage, and of its formidable and possibly fatal consequences, fettered the hand and stayed the knife of the boldest of the old operators. It paralysed indeed and retarded the whole progress of surgery for many long centuries; and, latterly, surgical science has marched forward very much in proportion as the knowledge of surgical hæmostatics has advanced. In many diseases, where the modern surgeon freely and fearlessly uses the scalpel and bistoury, the ancient surgeon operated—where he operated at all—with red-hot cauteries, chemical caustics, and strangulating ligatures. Hæmorrhage, with its perils and terrors, frequently prevented him from performing operations which now every surgical tyro looks upon as comparatively simple and safe. Thus the distinguished French surgeon Dionis incidentally tells us, that in the beginning of the last century he could not find, in the great and ancient city of Marseilles, a single surgeon who had ever performed the operation of excision of the diseased mamma.[1] According-ing to Celsus,[1] the patients who in his day were subjected to amputation often died from hæmorrhage and fainting during the course of the operation; and as late as the beginning of the seventeenth century, the great Italian anatomist and surgeon, Fabricius ab Aquapendente,[2] seems still to have been so appalled by the frightful and sometimes fatal bleeding which followed the stroke of the amputation knife in living tissues, that he recommended all the incisions for the dismemberment of a limb to be made only in mortified and, consequently, in lifeless and bloodless structures.[1] Even as late as near the middle of the last century, Samuel Sharp, surgeon to Guy's Hospital, and the pupil of Cheselden, unaware apparently of the instances of amputation of the shoulder previously performed and recorded by

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[1] *Dionis.*—"Cours d'Operations de Chirurgie," 1708, p. 324.

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[1] *Celsus.*—" Sæpe in ipso opere, vel profusione sanguinis, vel animæ defectione moriuntur."—(De Re Medica, lib. vii. cap. iv. sect. 3.)

[2] *Fabricius ab Aquapendente.*—See " Hieronymi Fabricii ab Aquapendente, Medico-Chirurgorum toto orbe Præclarissimi, Opera Chirurgica." Leyden, 1723, pp. 103, 104, 628, and 629, in his chapters " de Sphaceli Curatione," and " de Sphaceli Chirurgia." He boasts that by cutting through the dead parts of the limb, in cases of amputation, he avoids the two great evils of (1) pain and (2) hæmorrhage, " *nullus concitatur dolor, nec timeter sanguinis profusio.*" " In many parts of his works he [Fabricius] gives us," says Mr. Sharp, " a lively picture of the deplorable state of surgery with regard to amputations. He acknowledges the dreadful uncertainty they were under of stopping the blood by the actual cautery."—(See Sharp's " Critical Enquiry into the Present State of Surgery," 4th ed., p. 306.)

---

[1] *Amputation; the fear of it in former times.*—The most popular English treatise on surgery, in the latter half of the seventeenth century, speaks of amputation of the limbs, in any of its forms or varieties, as something "dreadful."—(See Cook's "Marrow of Chirurgery," p. 202.) Amputation is, says Purmann, "a *more* terrible and dreadful operation than any in the whole art of Chirurgery."—(See his "Chirurgia Curiosa, or the Newest and most Curious Observations in the Whole Art of Chirurgery, by M. G. Purmannus, Chief Chirurgeon of the City of Breslaw," London, 1706, p. 209.) According to Woodall, surgeon to St. Bartholomew's Hospital, amputation "is *the* most lamentable part of Chirurgery," and "the dismembering of any man whatsoever is never to be undertaken by any Artist without judicious preconsideration."—(See "The Surgeon's Mate, or Military and Domestique Surgery," pp. 156 and 400.) Writing in 1765, Sylvester O'Halloran, when describing such a simple operation as the amputation of the leg below the knee, speaks of the violence of the bleeding as both "the most troublesome and alarming symptom, and the most reproachful to the surgeon;" and he adds, that when this amputation was performed according to Verduin's method, "hæmorrhage alone has often proved fatal to the patient."—(See his "Complete Treatise on Gangrene and Sphacelus, with a new Method of Amputation," pp. 237 and 261.)

Le Dran, Morand, and others, remarks that there are cases which require this amputation; "but," adds this leading London surgeon of his day, "the apprehension of losing their patients on the spot by the hæmorrhage has deterred surgeons from undertaking it."[1]

Though in modern days stripped of its ancient terrors, hæmorrhage still forms a study of the very highest surgical importance, because it constitutes a complication in almost all varieties of severe surgical operations—in all in which the knife is employed. Hence, any question of moment connected with it is a question which is at once connected with nearly the whole range of operative surgery. Supposed improvements in individual operations—as in the position, for example, or the length, or the breadth, or the shape of the incisions or flaps in any special amputation—affect that one special amputation only, and have little or no bearing on general surgery. Their discussion, however interesting, is comparatively trivial, because the subject is narrow and limited. Any leading question, on the contrary, connected with hæmorrhage involves its application, not to any one special amputation, but to *all* amputations and to *all* other operations in which the surgeon uses cutting instruments.

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[1] *Amputation at the Shoulder.*—Sharp's "Treatise on the Operations of Surgery," 3d edit. (1740), p. 221. He had, he says, "heard of its having been done once."

In yet another point of view, the subject of hæmorrhage is most important. The means of arresting bleeding in surgical wounds, and the means of closing and healing these wounds with such quietude and rapidity as to conduce alike to the comfort and the safety of the patient, are two departments of practice which have always advanced hand in hand in the past progress of the art. Improvements in surgical hæmostatics have led on to corresponding improvements in the management of surgical wounds. For they are two matters of practice that are inseparably allied; though forming, as it were, the one the commencement and the other the end of every surgical operation. "Indeed," as was remarked half a century ago by my beloved and sagacious master, Professor

Thomson, "the suppression of hæmorrhage and the reunion of divided surfaces are in every wound and in every operation the first and the ultimate object of the surgeon's attention."[1]

Hitherto, if we exclude minor measures, there have been employed by surgeons two great methods or modes of staunching surgical hæmorrhages. Cauterization—the first of these two modes—consists of the application of red-hot iron cauteries or of chemical caustics to the orifices of the bleeding vessels, with the object of swiftly forming such a crust or eschar[2] at and over the site of these cor-

[1] *Thomson.*—"Lectures on Inflammation," p. 249.

[2] *Crust or eschar from cauterization.*—The mechanical obstruction at the mouths of the open arteries, effected by surgeons when they used cautery irons after amputation, is tersely described by Fabricius ab Aquapendente as follows:—"Artifices partem urunt et parant crustam satis crassam, quæ operculum firmum est vasorum."—See his "Opera Chirurgica" (p. 103). The experiments of Bouchacourt have shewn that when a bleeding orifice is cauterized by iron instruments at a low red heat—the best temperature for the purpose—the three tunics of the artery become inverted or rather invaginated backward into the opening of the arterial tube, and thus tend more or less completely to block up its extremity.—(See Malgaigne's "Médecine Opératoire," p. 40.)

rugated orifices, as will block and seal them up for a time sufficient to allow of their consolidation and obliteration. Deligation—or the second of the two modes referred to—is the physical constriction and obstruction of the canals of the divided arteries by tying with sufficient tightness a thread ligature around them, immediately above their open extremities. The obstruction of a divided artery—whether effected by cauterization or by deligation—is in the first instance purely *mechanical* in its character, and so far temporary; the permanent and complete closure of them which follows is the result, on the contrary, of a series of *vital* processes which is immediately set up in and around the orifice and tube of the obstructed vessel. It is almost unnecessary to remark that the latter of the two methods mentioned—namely, deligation or the ligature—is, with the occasional exception of torsion for the smaller arteries, the mode of arresting surgical hæmorrhage almost universally adopted[1] by all British surgeons at the present day in all their principal wounds and operations.

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[1] *Deligation almost universally adopted.*—British surgeons certainly use cauterization very rarely at the present day. But

The object of the following pages is to describe a third general method of suppressing the bleeding incident to surgical wounds and operations by the

"it may happen", says Mr. Porter, "that an artery shall be wounded in a situation that cannot be reached, as in operations about the antrum, the root of the tongue, or other parts of great depth or intricacy. Under such circumstances, there is no resource but the actual cautery, and in general it is very successful."—(Observations on Aneurism, p. 30.) Even under such circumstances, the actual cautery is in modern times more and more seldom used in English practice. In French surgical practice, the cautery is employed more frequently. See an enumeration of the various circumstances in which it should or may be used by Bérard in the Dictionnaire de Médecine (1837), vol. xv. p. 232. I have not thought it necessary to allude in the text to the use of heat as a *preventative* hæmostatic in the galvano-caustic apparatus of Professors Marshall and Middeldorpf; nor to the employment with the same view of the écraseurs of M. Chassaignac; nor to the old "ligature en masse" of common surgery, used in the removal of polypi, hæmorrhoids, etc. For the subject of the present essay is the arrestment of hæmorrhage produced by cutting surgical instruments, and the rapid reunion of the resulting wounds. The adoption of any of the three varieties of preventative hæmostatics alluded to is the formation of wounds in which there is, of necessity, no hope of and no attempt at primary union.

so-called process of Acupressure. It consists of the artificial arrestment of the hæmorrhage from cut or wounded arteries, by the pressure of a metallic needle or pin passed across their mouths or tubes. In order to understand the advantages of this process of Acupressure, let us first attempt briefly to inquire into the causes which prevent the general closure of large surgical wounds, such as amputation wounds, by primary union, when the ordinary hæmostatic measures of the past and of the present day are employed.

CHAPTER II.

IMPEDIMENTS TO THE PRIMARY UNION OF WOUNDS.

I TAKE it for granted that it is the aim and the desire of every philosophic English surgeon to heal, as far as possible, all his wounds by the "first intention,"[1] or by primary adhesion.

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[1] *Healing as far as possible all wounds by the first intention.* "The plan," observes Mr. Cooper, "of bringing the edges of the wound together after amputation, so that they may unite by the first intention, has received, for many years past, the universal approbation of British surgeons. It is their general practice, in the treatment of all incised wounds. It may be said to be the pride of English surgery.—(Dictionary of Practical Surgery, 7th edition, 1838, p. 65.) "There is no wound (as stated by Mr. John Bell) in which we may not try with safety to procure this adhesion; nothing surely can be more kindly, when applied to a wounded surface, than the opposite surface of the same wound. It has been but just separated; it may immediately adhere to it; though it do not adhere *no harm is done;* still the wound will suppurate as kindly, as freely, as if it had been roughly dressed with dry lint, or some vulnerary balsam or acrid ointment."—(Principles of Surgery, 1801, vol. i. p. 46.) "It is productive," remarks Mr. Cooper, "of *no*

In the olden times of surgery, when the hæmorrhages accompanying operations were arrested only by cauteries and caustics, all thoughts of effecting union by the first intention were of course idle and vain; for the existence on the surface of the wounds of the resulting dead sloughs and burned crusts totally and utterly prevented all chances of primary adhesion. But even after cauterization began to be abandoned for styptics, compression, and deligation, it was with difficulty and distrust that the idea of the union of wounds by primary adhesion began[1] to be entertained and

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danger; there is nothing better to be tried; and if it fail, what is the harm? Why, the wound will then heal by suppuration and the granulating process, just as soon as if the hollow of the stump had been filled with charpie, or left open; it will, in fact, heal in a way which is less advantageous than union by the first intention, but which is the best that can now happen."—(Dictionary of Practical Surgery, p. 65.)

[1] *Primary adhesion began.*—Mr. Sharp, writing in 1761, observes on this point, "There have been attempts made within these fourscore years to render amputations less dangerous, by devising a method of *healing the wound by the first intention.* The first essay of this kind is to be seen in the *Currus Triumphalis è Terebintho,* printed at London in the year 1679, though the merit of the invention is ascribed either to Verduin or Sabourin, who each contended for it many years after."—(Critical

attempted in cases of amputation by Yonge, Verduin, Sabourin, Vermale, Garengeot, etc. Betimes, however, as in the early half of the last century, the use of the ligature of arteries "by degrees *crept* into practice,"[1] the doctrine also of the

Enquiry into the Present State of Surgery, 4th edit. p. 292.) Mr. Yonge, who practised at Plymouth, describes for the first time, in the essay referred to, the method of amputation by flaps, and speaks of it as "a way of amputating large members so as to be able to cure them *per symphisin* in three weeks, and without fouling and scaling the bone." He ascribes the original merit of this method of operating to Mr. Lowdham, a surgeon of Exeter. In urging afterwards (in 1696) the advantages of a single flap operation in amputation below the knee, Verduin mentions that he had heard of the flap operation as practised by a surgeon in London; and he argues for the propriety and possibility of union of the stump by the first intention, in the following terms:— "Decurtationem ipsam quod spectat; mirum in modum nec semper affecit, promptum illud et stupendum naturæ opus, in partibus sibi invicem agglutinandis, licet longissimè dissitis, si abscissâ cute, labra earum vulnerata et sanguine madentia, proximè duntaxat ad invicem jungantur, ac probè conjuncta ferventur, cujus rei frequentissima in praxi meâ habui exempla, imprimis in restituendis labiis leporinis, etiam maximè distantibus; unde mihi aliquoties in mentem venit, an non in decurtandis artubus simile quid præstari posset?"—(De Novâ Artuum decurtandorum Ratione, p. 5.)

[1] *By degrees crept into practice.*—These significant words are used by Mr. Sharp, when speaking of the slow progress of the deligation of arteries, in his "Critical Enquiry into the Present State of Surgery," edit. 1761, p. 299.

union of amputation and other large wounds by the first intention, came to be supported and advocated by Sharp,[1] Alanson,[2] and other English surgeons.[3] Still, however, some practitioners denounced the very idea of primary union as improper and indeed as impracticable. Thus O'Halloran, in 1765, stoutly maintained that "healing by inosculation without suppuration, by an immediate coalescence, or by the first intention, is merely chimerical and is opposite to the rules of nature;"[1] and this surgeon and others assiduously dressed the entire interior surfaces of their stumps and flaps, for ten, twelve, or fourteen days after operation, with ointments and lotions, thus effectually preventing all adhesion, by preventing at every point the very contact of the raw surfaces of the wound. The surfaces of the stumps and flaps, which were intended to be ultimately joined and brought together, for secondary reunion, in a full granulating "well-digested" state, about the end of the second week, were up to that time separately dressed, in the language of O'Halloran, as "distinct sores" (pp. 240 and 245). He and almost all other surgeons[1] of his own and even of later days, applied their primary dressings and medications to the interior instead of the exterior of their wounds—to the inside instead of the outside of them.[2] They ruthlessly pushed and packed their lints, pledgets, and salves, into the very centres of their amputation wounds, and as carefully dressed the ends of the divided bones,[3] as their surgical brethren in preceding ages had carefully cauterized these bones.[4]

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[1] *Sharp.*—"For the symptomatic fever," observes Mr. Sharp, "and the great danger of life attendant upon an amputation, does not seem to proceed purely from the violence done to nature by the pain of the operation, and the removal of the limb, but also from the difficulties with which large suppurations are produced; and this is evident from what we see in very large wounds that are so circumstanced as to admit of *healing by inosculation*, or, as surgeons express it, *by the first intention;* for in this case we perceive the cure to be effected without any great commotion; whereas the same wound, had it been left to suppurate, would have occasioned a symptomatic fever, etc.; but in both instances, the violence done by the mere operation is the same, whether the wound be sewed up or left to digest."—(Critical Enquiry, p. 290.)

[2] *Alanson.*—See his Chapter, headed "On what is called Union by the First Intention;" in his "Practical Observations on Amputation," 2d edit., 1782, p. 153, *seq.*

[3] *Other English Surgeons.*—See the works of Benjamin Bell, John Hunter, William Hey, John Bell, etc.

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[1] *O'Halloran.*—"Treatise on Gangrene and Sphacelus, with a New Method of Amputation," p. 220. He vainly tries elsewhere (p. 213) to shew that Garengeot must be misstating the facts when he mentions the rapidity with which he had found the flaps in some amputations adhere; and especially when he describes one in which the flap was united to the stump in three days. In reference to this last case, O'Halloran sceptically exclaims, "I would ask the ignorantest tyro of the profession, if ever he saw, or even heard of, a wound of but even an inch long being united in this time? And behold, here, an immense mass of flesh, almost that of the whole leg: a complete division of nerves, muscles, blood-vessels, and bone, united in that space!"

Led away by the high authority of Pelletan,

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[1] *Other Surgeons.*—See the works of White, Gooch, Bromfeild, etc.

[2] *Dressings placed outside of wounds.*—Mr. Alanson puts as a heading to some of his surgical cases, the significant words, "Dressings applied *exterior* to the surface of the wound."—See his Work, pp. 289, 292, etc.

[3] *Bones dressed in amputations.*—See for instance, Bromfeild, who recommends dry lint as "the proper dressing on the bone," "Chirurgical Observations and Cases," vol. i. p. 174 ; and Moyle, who advises us to defend the bones "and the marrow with dorcels of dry towe or lint ; then apply your dismembring pledgits with your restringents."—See "The Sea Chirurgion," p. 67.

Cauterization of bones.—In describing amputation, John de Vigo tells us, "the bone must be sawed with a keene sawe, and after that it is cut with a sawe, it *must* be cauterised with

Larrey, Gensoul, Dupuytren,[1] and others, some foreign surgeons still methodically reject all attempts at primary union in most wounds; possibly because, from their peculiar mode of operating, and especially of dressing wounds, they have found their failures so constant as to make them despair of success. I saw not long ago one of the greatest and most distinguished surgeons of the continent slice off, by an instantaneous scalping stroke of his large knife, the whole mamma, in a case where that gland was the seat of a cancerous tumour. He did not try—as would have been done by every English surgeon

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an actuall cauterie." See the English Translation (1586) of "The whole Worke of that famous Chirurgion Maister John Vigo," p. 43. In the words of Fabricius Hildanus, the surgeon, after amputation, "cauteriis vasa inuret ad sistendum sanguinem, ipsumque etiam os, quò citiùs excidant ejus fragmenta."—(Opera Omnia, 1646, p. 811.)

[1] *Dupuytren.*—Only in his primary or traumatic amputations did this great French surgeon recommend union by the first intention.—(See his "Leçons Orales," 2d ed., tom. ii. p. 405). His countrymen, Roux and Richerand, held, exactly contrary to Dupuytren, that traumatic amputations were the most improper and unfavourable of all for attempting primary union with.—(See Cooper's "Dictionary of Practical Surgery," p. 65.)

—to dissect back and save the undiseased skin to close over the excavation made by the removal of the diseased mass itself; but swept off the whole mamma, skin and all, leaving a large open uncoverable gash, which, after the arteries were secured, was dressed with charpie, etc. When wounds, however, instead of healing by the first intention, are thus made to heal by granulation and cicatrization, or by the " second intention," they usually close slowly and painfully,[1] with more or less prolonged discharges and suffering to the patient —often with the loss of health, and not unfrequently also with the loss of life.

The regulation of the closure of wounds in operative surgery by the first intention or by the second intention occasionally depends upon the constitutional health and state of the patient, and upon the hygienic and other circumstances in which he is placed. It always, however, depends also, more or less—and generally almost entirely—upon the local character and circumstances of the wound, and particularly upon the free and perfect coaptation of its opposed surfaces. I have seen, on dissection, a revivified vesico-vaginal fistula perfectly and entirely united within five days after it was operated upon, though the patient during that short interval was the subject of a mortal attack of pelvic cellulitis and peritonitis,[1] with the amount of constitutional disturbance usually seen in such fatal cases. And the question before us is this: Is surgery as yet prepared, or is it yet able, to take an additional step forwards, with the hope of rendering the management of wounds such that their primary union should prove much more general than heretofore? If so, the practitioner might, when successful, abridge the cure of amputation wounds, for example, from long weary weeks, or even months, almost to days only; and he would doubtless add vastly, in doing so, both to the happiness and comfort as well as to the security and safety of his patients.

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[1] *By the second intention wounds usually close slowly and painfully.*—Thus, when speaking of the old method of treating amputation wounds, M. Velpeau observes, " It exposes to conicity of the stump, to necrosis of the bone, to exhaustion of the patient by the abundance and persistency of the suppuration, and to dreadful pain at every dressing; it requires three, four, five, six, and even seven or eight *months* to accomplish the cicatrization, and it ordinarily furnishes but a very thin cicatrix, which gives way upon the slightest effort."—(Nouveaux Eléments de Médecine Opératoire, tom. i. p. 334.)

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[1] *Closure of a vesico-vaginal fistula in a patient who died five days after the operation.*—The case I allude to was one where the operation was difficult, from the incarceration of the cervix uteri within the bladder. It was very ably performed in Edinburgh by Dr. Bozeman.—(See Dr. Keiller's Report in the "Edinburgh Medical Journal" for October 1858, p. 330.) The case, says Dr. Bozeman, "should be considered entirely successful, notwithstanding the death of the patient . . . In the autopsy we found the suture apparatus as perfectly adjusted as the day it was applied, with the result of a *perfect* union of the edges of the fistula. The pyæmia, of which the patient died, should, I think, be considered apart from the operation."—(See Dr. Bozeman's

Now, there are some wounds that heal with nearly perfect certainty by primary union, although from certain correlative circumstances they seem not to be very favourably situated for such a result. Thus, the raw edges of a vesico-vaginal fistula, when brought together with metallic wires, almost always cohere, despite the constant contact of urine; the lips of a ruptured

Letter in "Medical Times and Gazette" for Nov. 27, 1858, p. 561.)

and revivified perineum, despite the irritation of the intestinal contents; and the wound in harelip, despite the presence of the saliva.

In fact, the wounds in all operations in "plastic surgery" are expected to unite by primary adhesion, and generally do so. Why is it that these classes of cut wounds commonly heal entirely by the first intention, while large cut wounds in "general surgery" rarely cohere throughout in the same manner? For, confessedly, the complete and perfect primary union of a wound such as is left by the removal of a limb, mamma, or tumour, is not often seen in general surgical practice.[1] I believe that the answer is this: In the obstetric operations named, and in other cases of plastic surgery, *no ligatures of the arteries are used.* On the contrary, in the wounds of general surgery which fail to cohere by primary union, ligatures are used in greater or less number to arrest the arterial hæmorrhage. It is, in short, the absence or the presence of these ligatures tied around the ends of the bleeding arteries, that makes the marked and distinctive difference between wounds likely to heal and wounds not likely to heal by the first intention. But then arises the next question,—Why do the ligatures interfere with the primary adhesion of wounds?

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[1] *Rarity of primary union in some wounds.*—"The wound," to quote the words of one of the most eminent surgeons of Germany, "after amputations of large limbs, *never* takes place by complete agglutination in the strict sense of the word."—(See the "System of Surgery" of Professor Chelius of Heidelberg, South's Translation, vol. ii. p. 904.)

Arterial ligatures prevent the primary union of the lips of wounds in two ways—(1.) By acting as extraneous and irritating bodies, and hence as miniature setons; and (2.) By their necessarily producing strangulation and sloughing of every tied artery at the part of deligation.

CHAPTER III.

LIGATURES OBJECTIONABLE AS FOREIGN AND IRRITATING BODIES.

EACH ligature is necessarily a mechanical foreign body placed between the opposed sides of the wound. When it is composed of silk or other organic material, it rapidly imbibes, from the surrounding tissue, animal fluids into its substance; and these dead fluids speedily decompose and render the threads morbidly poisonous and irritant agents to the contiguous living tissues. In a future chapter, when discussing the possible effects of ligatures upon the origin of some constitutional complications that are liable to follow upon surgical operations and wounds, I shall adduce experiments on the lower animals, shewing that organic suture-threads, and hence organic ligature-threads, generally become in a few days so loaded with irritant matter, that when taken out and buried at that time in the depths of recent wounds in other animals, they, as a usual effect, quickly excite in the tissues around them suppurative and sometimes furunculoid inflammation. In other words, each arterial ligature is formed speedily into a small or miniature seton,[1] and it produces, like a seton, suppuration along its track.[2] Suppuration, however, and all the higher grades of inflammation, are locally antagonistic of adhesive inflammation or primary union; and they tend to impede and subvert those processes of cohesion and repair which constitute union by the first intention.

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[1] *Each arterial ligature a small or miniature seton.*—The expression here used is that employed by the late distinguished Irish surgeon, Mr. Porter of Dublin. When speaking of the effect of the arterial ligature in wounds, he observes, "It is evident that until its removal the wound cannot be made to unite by the first intention, and where there are many of them, as on the face of a stump or other extensive surface, their presence, *acting as so many setons*, keeps up irritation and often a profuse discharge.—(See his "Observations on the Surgical Pathology and Treatment of Aneurism," 1840, p. 29.)

[2] *Suppuration produced by ligatures.*—"If," says John Hunter, "any extraneous body, such as a ligature, should have been left in the wound, suppuration *will* take place."—(Hunter's Works, edited by Palmer, vol. iii. p. 258.) "Ligatures act as foreign bodies in wounds, exciting irritation, preventing adhesion, and producing suppuration."—(See Blair and Cooper in "Rees' Cyclopædia," vol. xvii., article Hæmorrhage.) "Ligatures," observes Mr. Lawrence, "being foreign bodies in contact with the surface of the wound, must irritate, *must* cause inflammation and suppuration. In amputations, where it is necessary to secure

It would be easy to cite the observations of various surgeons, in regard to inflammation, particularly in its higher grades, being always liable to be antagonistic to union by the first intention. The fact is so well known, and so generally acknowledged, that I shall content myself with citing one high authority only, namely, Mr. Syme. When speaking, in his Principles of Surgery, of "inflammation being preventive of primary union," Mr. Syme remarks, "It is now ascertained that inflammation, so far from being essen-

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many vessels, a large portion of the wound is exposed to this irritation, its union is retarded, and considerable pain and spasm are sometimes produced. Are these evils inseparable from the use of ligatures? or is there any plan by which we can avoid them?"—(Medico-Chirurgical Transactions, vol. vi. p. 162.) The distinguished French surgeon, M. Roux, states, "The ligatures are extraneous bodies, which, as long as they remain in the wound, irritate it, determine and keep up suppuration."—(Narrative of a Journey to London, 1816, p. 119.)

tial to the process, is subversive of it. A certain degree of excitement," he adds, "is not incompatible; but whenever it goes so far as to occasion pain, or much swelling and redness, union by the first intention is frustrated; and the way is led to another process of reparation, viz., granulation."[1]

Fig. 1.

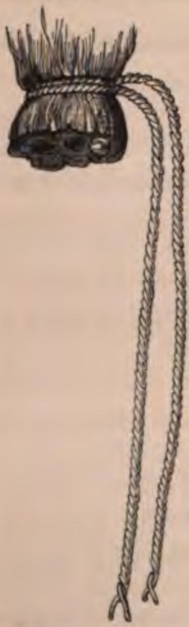

Fig. 1. Ligature, including artery, vein, nerve, and portions of surrounding tissues.

Surgeons have made various attempts to get rid of the action of ligatures as foreign and irritating bodies, by diminishing the quantity of parts included in the loop, altering the thickness and size of the ligature, changing its material, etc. (1.) In olden times they were in the habit of systematically including portions of the surrounding tissues in the loop of the ligature,[2] as represented in the woodcut, Fig. 1. But the process of ulceration, etc., by which each ligature cuts through the part it embraces, was thus

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[1] *Syme.*—See his "Principles of Surgery," 1863, p. 41.

[2] *Inclusion of surrounding tissues in the loop of the ligature.*—In originally describing the ligature of vessels, Ambrose Parè

states, that in seizing the bleeding end of the vessel with the crow-bill forceps, "You neede take no great care, if you together with the vessells comprehend some portion of the neighbouring parts, as of the flesh, for hereof will ensue no harme."—(Parè's Works, English ed., p. 459.) The same doctrine and practice held for at least two centuries afterwards. When describing amputation at the thigh, O'Halloran remarks, "The femoral artery should be taken up with a large convex needle, well threaded, the threads flat and waxed; and in doing this operation, it is not necessary to include with the artery a large parcel of muscular flesh. In fact, a small portion, with the cellular substance of the *adjoining muscles*, will form for it a soft cushion; and the swelling of them will sufficiently compress the artery, as well as secure it from any abrasion of the ligature."—(Treatise on Sphacelus and Amputation, p. 249.) Having all his ligatures ulcerated off and removed before he brought his stump and flaps together for secondary reunion, O'Halloran did not fear to include other parts with his ligature. He is the only author who, as far as I recollect, mentions bone as comprehended within ligature-threads. But he used it sometimes as a counter-pressure. Thus, he remarks, when treating of amputation below the knee, "Where the flesh was thin and not very firm, I have, more than once, made a ligature *round the bone*, in which the artery was included" (p. 235). The first Professor Monro of Edinburgh, in the earlier half of the last century, urged the propriety of taking up the arteries after amputation, with as few surrounding fibres as possible within the noose of the ligatures.—(Edinburgh Medical Essays and Observations, 1737, vol. iv. p. 329.)

found to be unnecessarily protracted, and when the included nerves[1] became irritated, great pain and suffering were sometimes the result.[2] Hence arose (2.) the rule of including within the ligature nothing but the arterial tube itself. After this important reform was introduced, the arterial tubes were by many surgeons tied (3.) by large, thick, and sometimes flattish thread and even tape ligatures, with the view chiefly of averting secondary hæmorrhage from the too rapid division of the tissues of the vessel. For a similar purpose, other surgeons—led principally by the teaching of the celebrated Scarpa on the ligature of the tubes of arteries in the cure of aneurism—reverted (4.) to the old plan of placing a protecting body, as pieces of linen, cork, etc., between the artery and the surrounding ligature.[1] Both these plans were

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[1] *Inclusion of nerves in the ligature-loop.*—The celebrated French surgeon Petit, who died in 1750, tells that in his younger days he had been present at several discussions among the great master surgeons of that time, and had heard one section of them say, it was quite immaterial whether the *nerve* were ligatured or not; while the others maintained, that as they tied the vessels in order to restrain the blood, so it was no less necessary to tie the nerves, *lest* the animal spirits should escape.—(Traité des Maladies Chirurgicales, tom. iii. p. 197.) The opinions and practice of such a very great surgeon as John Hunter, upon the inclusion of nerves, are such as would scarcely be reckoned orthodox by the operators of the present day. In his "Lectures on the Principles of Surgery" he maintained that the including of the nerve with the artery in the noose of the ligature generally produced no bad symptom: "I have sometimes," said he, "tied nerves *on purpose* along with the artery."—(See Palmer's edition of Hunter's Works, vol. i. p. 541.) Mr. Moore, in his essay, published in 1784, and entitled, "Method of Preventing or Diminishing Pain in several Operations of Surgery," by antecedent compression of the nerves of the limb, describes a case in which the plan was tried in the practice of John Hunter in an amputation of the thigh; and he incidentally tells us that in that case "the great nerves" were included by Mr. Hunter in the ligatures of the arteries.

[2] *Effect of ligature sometimes very painful.*—One noted case, illustrative of this remark, is interwoven with the naval history

of England. When Lord Nelson made his unsuccessful attack on Santa Cruz, on the 25th July 1797, he received, as is well known, a gunshot injury of his right elbow, which necessitated immediate amputation. One of the silk ligatures used in the operation included a nerve as well as an artery, and perhaps other tissues. The ligature, in consequence, did not separate till the end of November, or four months from the time of its application. During that period the sufferings of Lord Nelson were, according to his biographer, Mr. Southey, " long and painful ;" there was " a constant irritation and discharge, and the ends of the ligature, being pulled every day, in hopes of bringing it away, occasioned fresh agony."—(See Southey's " Life of Nelson," p. 129.)

[1] *Old plan of placing a foreign body between the artery and the ligature.*—Writing on amputation some 130 years ago, Pro-

found to produce, however, rather than to avert the tendency to secondary hæmorrhage; and in British practice they were betimes entirely replaced by (5.) ligatures as small and slender as was compatible with due strength (see woodcut, Fig. 2.) To diminish the bulk of the foreign body or ligature in the wound, the practice was next adopted of (6.) cutting off one end or limb of the li-

Fig. 2.

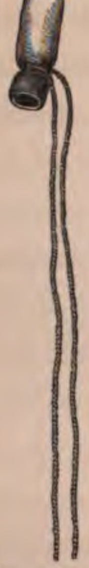

Fig. 3.

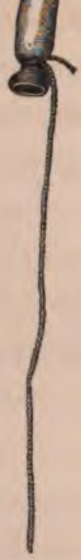

Fig. 4.

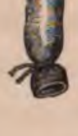

Fig. 2. Ligature of ordinary thickness surrounding artery alone.

Fig. 3. Shews one end of the ligature cut off.

Fig. 4. Shews both ends of the ligature cut off.

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fessor Monro observes, in relation to the ligatures of the cut arteries, that "the compress of linen, recommended by some authors to be put between one side of the artery and the noose of the thread, cannot be approved; the effects of it being to prevent the tight enough ligature of the vessel; and if it should shuffle out soon, a hæmorrhagy must be expected; or if it remains, the pus which it imbibes will become too acrid."—(Edinburgh Medical Essays and Observations, 1737, vol. iv. p. 332.)

gature after the knot was tied, as represented in woodcut, Fig. 3. Others, with the vain hope that the mere loop of a silk ligature might remain buried permanently—though a foreign body—within the depths of the wound, proposed (7.) that both ends of the ligature should be cut off,[1] as in Fig. 4;

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[1] *Both ends of the ligature cut off.*—"The practice," observes Mr. Liston, "of cutting off both ends of the ligature, was at one time very much in fashion. It was thought that the mere noose or knot might by possibility remain imbedded in the living tissues, surrounded by a cellular cyst, and occasion no annoyance . . . All these hopes have been disappointed; ligatures, of whatever substance, do now and then remain hid for a long time, but very generally they occasion trouble. After the cure has been thought complete, they give rise to irritation, pain, inflammatory swelling, and formation of matter; abscess after abscess ensues, one knot comes out after another, and ultimately all the offending foreign bodies are expelled. The perfect recovery is thus very long protracted.—(Liston's "Practical Surgery," 4th ed. p. 24.) "Numerous experiments," to quote the observation of Professor Chelius, "prove that re-opening of the wound, suppuration, fistulous passages, and the like, may be produced by the knots remaining."—(See his "System of Surgery" by South, vol. i. p. 306.) Mr. Lawrence, the principal advocate of cutting the ligatures off short, has, I believe, long given up the practice himself. He, and before him Delpech, Walther, Hennen, and Haire, followed the practice as one calculated to promote primary union, by the extraneous body, or limbs at least of the ligature, not being allowed to remain between the lips of the wound. A

a practice followed with little immediate success, and often with much future local disturbance and distress from the irritation of the buried threads. The chances of union of wounds by the first intention have been further attempted to be advanced, by changing also the constituent materials of the ligature. Instead of vegetable threads of flax or hemp (8.), animal ligatures of cat-gut, silk-gut, buckskin, fibres of the sinew of the deer, etc., have been employed, under the vain expectation that they would prove less irritating to the wound, as approaching more nearly to the living animal tissues. And, lastly (9.), ligatures of metallic thread have also been placed around bleeding arteries with the same hope; and though not irritating, so far as the material of which they are composed is concerned, yet metallic ligatures, like any other form of ligature drawn tightly around bleeding arteries, and left there to ulcerate through

century ago (1765), O'Halloran, in describing amputation of the thigh, laid down, as one of the rules for the operation, "Let the threads be cut short" (p. 250). But, when issuing this recommendation, he had no idea of attempting to unite his flap-amputation wounds by primary adhesion.

the constricted tube, usually excite, in the course of their ulcerative progress, too high irritation and inflammation to allow surgical wounds in their immediate vicinity to unite by the first intention. Besides, as we shall find in the sequel,[1] in almost all the instances in which metallic ligatures have hitherto been applied to the open extremities of arteries in wounds, they have been drawn with as much force as silk ligatures, and consequently have led, equally with silk ligatures, to the injurious result which we have next to consider—namely, the strangulation and death of the tied point of the vessel.

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[1] *Metallic ligatures.*—See on this subject of the application of metallic threads or ligatures to arteries, the chapter in the Appendix, No. III.

CHAPTER IV.

LIGATURES OBJECTIONABLE AS STRANGULATING AND SLOUGHING THE ARTERY AT THE POINT TIED.

LIGATURES, besides acting as extraneous and irritating bodies, counteract the simple adhesion and healing of wounds in another and a still more direct and deleterious mode. They inevitably excite at all the ligatured points and ends of all the tied arteries, stages of inflammation higher than the adhesive—the stages, namely, of ulceration, suppuration, and *mortification*. For at the point of deligation—as deligation is now generally practised—every ligatured artery, after being partially drawn out by the forceps, and so far isolated, has its two inner coats mechanically torn through by the thread, and its outer coat strangulated by it; before the separation of the ligature can be effected, it requires to cut through the strangulated tube by a process of ulceration or molecular disintegration and gangrene; and there are set up, as a necessary consequence, in the immediate vicinity of the ligatured and strangulated artery, the processes of local disjunctive ulceration and suppuration; But further, the part of the arterial tube embraced in the noose of the ligature always and inevitably constitutes a small, dead, decomposing *slough*, as well as the isolated and strangled end or stump of the artery below the ligature, except in instances in which this isolated end is preserved from death, by organic adhesion either to the contiguous surfaces, or to the new deposit of fibrin which speedily encases the part. If two, four, or six arteries, therefore, are tied in a surgical wound, then, in consequence of this deligation, there exist two, four, or six points of *ulceration, of suppuration*, and *of sloughing*, in the depths and walls of that wound. And, of course, complete and *entire* primary adhesion of its sides becomes a practical improbability, or rather an impossibility.

All our best surgical pathologists acknowledge local ulceration and mortification, as thus the inevitable and invariable result of the ligature of arteries. Generally the dead tissue is thrown off in small slough-masses;—to a considerable extent, also, it seems to be melted down and discharged in the form of disintegrated ulceration-molecules. We tie and strangulate the necks of piles and polypi to make them ulcerate and slough off, just as the tied and strangulated ends of arteries do. Mr. John Bell, when treating of the effects of the ligature of the artery, uses this very comparison: —The part of the artery "below the ligature is (says he), destroyed like a polypus, fades and dies; and it is the fading of the lower part thus *mortified* that allows the noose of the ligature to slip off."[1] In the words of Dr. Wise—a very careful observer, and a gentleman who has specially attended to this department of pathology —after deligation of an artery—"an *ulceration* of the compressed part takes place about the fifth or sixth day, and the ligature is slowly discharged about the twelfth or fourteenth day, being thrown off by a *gangrenous* process, together with a small portion of the vessel which had been compressed by the ligature."[1] "Every surgeon knew," observed Mr. Spencer Wells, "that the part of the artery beyond the ligature *must be killed* by it, and that a piece of *sloughy* tissue cannot do any good when confined amid the living tissues of the body."[2] Unbiassed by any such discussion as the present, numerous authors, as Cross,[3] Guthrie,[4]

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[1] *Strangulation and mortification of tied arteries.*—(See his "Principles of Surgery," vol. i. p. 220.) Mr. Bell gives the following (page 217) as another illustration of the destructive effects of the ligature upon the arterial tube. "An artery," says he, "is a hollow tube, and may be more correctly resembled to a strangulated intestine; for the intestine is so compressed by the stricture of the ring, that the whole intestine is inflamed, the middle portion mortifies and sloughs off, while the two extremities, where the intestine is immediately compressed by the stricture, inflame and adhere to the ring."

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[1] *Wise.*—"Pathology of the Blood," p. 316.

[2] *Wells.*—"Med. Times and Gazette" for 5th May 1860, p. 459.

[3] *Cross.*—"If a thin ligature be drawn sufficiently tight upon a vessel, on the face of a stump, to be secure, I am persuaded that the extremity of the vessel, which becomes insulated as it were, *must die.*"—(London Medical Repository, vol. vii. p. 363.)

[4] *Guthrie.*—"The artery usually yields by *sloughing*, and the ligature is left at liberty by the ulceration which takes place in the sound part of the artery, immediately above and below the part strangulated by the ligature, and which part is frequently brought away in the noose."—(Commentaries in Surgery, 5th ed., p. 200.)

Thomson,[1] Brodie,[2] Hodgson,[3] Erichsen,[4] Roux,[5] Pécot,[6] Velpeau,[7] Nélaton,[8] and other surgical pathologists,[1] all describe the portion of every artery strangled and isolated by the ligature as killed, and requiring to *slough* off. Let me con-

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[1] *Thomson.*—"The part of the artery included in the ligature, being *deprived of its vitality*, separates from the living parts."—(Lectures on Inflammation, p. 253.)

[2] *Brodie.*—"It [the ligature] divides the middle and inner coats, but only compresses the outer coat. It makes a *slough* of a little piece of the latter; and when the ligature comes away, at the end of ten days or a fortnight, you find the slough in it."—(Lectures illustrative of Various Subjects in Pathology and Surgery, p. 306.)

[3] *Hodgson.*—"The ligature causes the *death* of that portion of the external coat with which it is in immediate contact. In a little time this *slough* is detached by ulceration, and the ligature is cut off."—(Treatise on the Diseases of Arteries and Veins, p. 194.)

[4] *Erichsen.*—"The pressure of the noose causes gradual *sloughing* and ulceration of the part included in it."—(Science and Art of Surgery, 1st ed., p. 135.)

[5] *Roux.*—"Care must be taken not to apply the thread too high above the mouth of the artery, so that a very small portion of the vessel shall remain below the ligature, destined to *mortify*."—(Narrative of a Journey to London, p. 120.)

[6] [7] *Pécot and Velpeau.*—"The experiments and arguments of M. Pécot tend to prove that . . . the portion of the arterial canal included in the noose of the ligature does *mortify*, almost as a matter of necessity, whatever be the degree of constriction which it sustains."—(Nouveaux Eléments de Médecine Opératoire, tom. i. p. 81.)

[8] *Nélaton.*—"The ligature strikes with *mortification* the part

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of the vessel which is submitted to the constriction."—(Elémens de Pathologie Chirurgicale, tom. i. p. 133.)

[1] *Other surgical pathologists.*—See, for instance, *Manec*, in his "Traité de la Ligature des Artères," p. 14; *Marjolin*, in the "Dictionnaire de Médecine," tom. xiii. p. 168; *Porter*, in his "Observations on the Surgical Pathology, etc., of Aneurism," p. 27; *Wardrop* on Aneurism, in the "Cyclopædia of Practical Surgery," vol. i. p. 239; etc. etc.

In the text and foot-notes I have only cited the authority of surgeons of the present century, with regard to the destructive and strangulating effects of ligatures upon arteries. As specimens of the doctrines of the surgeons of the last century upon the same point, I shall content myself with quoting two writers only, both of whom lived and practised in the first half of the century. "Threads," observes the first Dr. Monro of Edinburgh, "tying arteries, only come away afterwards by the tyed parts *mortifying* or suppurating away, and the sooner such corruption is brought on, which will be exactly in proportion to the tightness of the ligatures, the separation of the threads will be the more speedy."—(See his "Remarks on the Amputations of the Larger Extremities" in the Edinburgh Medical Essays, vol. iv. p. 331.) When discussing the degree of tightness to which the ligatures on arteries should be drawn, M. Petit, the celebrated inventor of one form of the tourniquet, remarks, that all that part of the vessel which is included in the ligature falls into *mortification* ("*tout ce qui s'est compris dans la ligature tombe en mortification.*")—(Traité des Maladies Chirurgicales, tom. iii. p. 195.)

tent myself with adducing in the text the statements on this point given by the authors of three of the latest and best works on Systematic Surgery, published respectively in America, France, and England :—" That portion of the artery (I quote the words of Professor Gross, of Philadelphia) immediately embraced by the ligature *mortifies,* and comes away in the form of a *slough.*"[1] " The portion of artery," remarks M. Chassaignac, of Paris, " embraced by the ligature *necessarily mortifies* a little sooner or a little later, whatever be the degree of constriction put upon it; and it is only in consequence of an eliminative process, similar to that which in gangrene separates dead from living parts, that it is detached from the tissues which surround it."[2] " The noose (of the ligature) and its contained *slough* are," remarks Professor Miller, " to all intents and purposes, foreign matter; as such their presence will be resented by the surrounding living textures;

[1] *Gross.*—" System of Surgery," 1862, vol. i. p. 700.

[2] *Chassaignac.*—" Traité des Opérations Chirurgicales," 1861, tom. i. p. 233.

and as such they will be extruded by suppuration."[1]

In the most ancient way of treating bleeding wounds, when heated irons or chemical caustics were applied to stem the attendant hæmorrhage, all chance of primary union was set utterly and thoroughly at defiance by the presence on the surface of the wound of the resulting carbonised and dead sloughs. Again, after the ligature began to be employed, we have seen that the surgeons of the last and of the preceding century still continued systematically to prevent all chances of primary adhesion by assiduously applying their dressings to the interior or raw surfaces of their wounds. All modern English surgeons profess to desire and to aim at the healing of wounds by the first intention, as far as possible. But still, though this is their avowed object, they persist in treating their wounds—in a greatly modified degree, however—after these two methods of their olden predecessors. For truly the body of the ligature itself is a remnant, though a minute one, of the dressings formerly placed on the inside and between the lips of the raw wound; and the sloughs produced by the ligatures are miniature but true representatives of the more general sloughs of the whole surface, produced by the old cauteries and caustics. The ancient and the modern practices in this branch of surgery differ extremely in degree; but they still correspond far too exactly in principle and in effect.

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[1] *Miller.*—"System of Surgery," 1864, p. 224.

CHAPTER V.

CONTRAST BETWEEN DELIGATION AND ACUPRESSURE.

SOME time ago, when asked by an excellent provincial surgeon how his leading metropolitan brethren and former teachers were treating their surgical wounds, I answered, that they were placing some minute morsels of dead flesh into the raw cavities or upon the raw sides of all their large wounds. My questioner looked greatly amazed—expressed his astonishment at such ideas being countenanced and adopted in high quarters—maintained rather stoutly that the practice must prevent primary union, and must be apt to give rise to pyæmia; and it was altogether, he seemed inclined to argue, a grievous and a lamentable retrogression in the principles and practice of sound and scientific surgery.

Indeed, if after the amputation of a limb or the removal of a tumour, any British surgeon at the present day were—ere he closed the wound—to avow it as his professed and predetermined intention to insert deliberately and carefully into the sides and depths of that wound a number of very small pieces of dead, sloughing flesh, taken from another diseased or dead human body; and, further, if he fixed or stitched these fragments of mortified flesh into the raw walls of the wound by a series of silken threads, and retained them there for a week or two—would the practice not be considered as most objectionable in its character, and altogether discreditable to the advanced state of modern surgical science? But if, in addition, the surgeon who treated the wounds of his patients in this manner—inserting into their sides minute masses of sloughing flesh, with seton-threads attached to them—were further to maintain that he expected that the wounds treated in this strange manner would unite by the first intention, would not his powers of judgment and reasoning be liable to be gravely doubted and denounced?

Yet in reality all this—as we have seen in the last two chapters—is virtually and truly the practice and principle followed at the present hour by surgeons, when they staunch the hæmorrhages which follow the use of their knife by tying silken ligatures around the drawn out and isolated ends of the bleeding arteries. For thus, in every wound, they (1.) artificially produce and make as many small masses of strangulated, dead, and sloughing tissue, and have (2.) as many small irritating seton-threads attached to these masses, as there are vessels tied. Further, they (3.) retain these small sloughs, and the long threads which are anchored to them, for five, ten, or more days, in the depths and sides of the wound, whose surfaces they wish to cohere throughout. (4.) Each separate arterial slough inevitably sets up around it an eliminative process of ulceration and suppuration, and every ligature-thread inevitably also excites suppurative irritation along its track. Is it a great marvel then that primary union so seldom occurs in wounds so managed? Would it not be a greater marvel if union by the first intention followed oftener under such adverse circumstances?

We cannot hope, I believe, for any great and decided improvement in the treatment of wounds, and we cannot expect primary union to be frequent in them, till we have attained some means of arresting hæmorrhage without strangulating and sloughing the ends of the bleeding arteries. Acupressure enables us to accomplish this object; for multiplied experience with the process has now fully and abundantly proved that it is capable of shutting up wounded and cut arteries—without producing upon them any physical laceration, such as the ligature produces—without strangulating and sloughing their isolated extremities—and without leaving any foreign bodies whatever in the wound after the vessels are fully occluded. The superiority of acupressure primarily depends upon the merely temporary and removable nature of the foreign occluding body; upon the relative slightness of the physical compression which it produces upon the tissues of the closed vessel; and upon the safe and unirritating character of the material or body employed in the process. This safety, again, of the material is founded upon the general pathological law, that, whilst silk and other dead organic ligatures and substances excite irritation, suppuration, etc., when they are buried in the living structures of the body, there is, on the contrary, a *tolerance of metallic bodies by the living tissues* of the body.

We have ample proof of the truth of this important general law of the tolerance of metallic bodies by living structures,[1] in many kinds of observation, as in the presence—sometimes for long years—of bullets, small shot, pins, and needles, embedded in different parts of the body; in the non-irritating character of threads of iron, silver, platinum, etc., when used as surgical sutures; in the employment by all our best surgeons of metallic pins or needles in the union of harelip; and in the safe retention, during several days, of a metallic needle passed through a fold of the peritoneum itself, in the operations of Wutzer, Rothmund, Bonnet, Wells, and others, for the radical cure of hernia. The use of a needle in the cure of hernia and of harelip—where the whole aim and the deliberate object of the surgeon is to secure and establish adhesion and adhesive inflammation—only shows that a needle, when employed to close and compress an artery, as in acupressure, is not likely in itself to lead there to any higher stage of inflammation than the adhesive—and consequently will not interfere, when used as a hæmostatic agent, with the primary union of wounds.

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[1] *Law of the tolerance of living structures for foreign metallic bodies.*—I have thrown the fuller consideration of this subject into the APPENDIX, No. I., in order not to interrupt too much the sequence of the discussion in the text. The matter in the Appendix consists chiefly of observations which I published in the "Medical Times and Gazette" for June 1858.

That even very long needles may be borne with perfect impunity embedded for days in the living body, is attested by numerous experiments that were performed, on the human body, some forty years ago, by various surgeons, when acupuncture was more studied and more practised than now.

"It is a *remarkable* circumstance (observes a writer of that date) that the acupuncture needles never cause inflammation in their neighbourhood. If they are rudely handled or ruffled by the clothes of the patient, they may produce a little irritation. But, if they are properly secured and protected, they may be left in the body for an *indefinite* length of time without causing any of the effects which usually arise from the presence of foreign bodies. In one of M. Cloquet's patients they were left in the temples for eighteen days; and in cases in which needles have been swallowed, they have remained without causing inflammation for a much longer period. It appears probable, from the facts collected on this subject, that metallic bodies of every kind may remain imbedded in the animal tissues without being productive of injury."[1]

Needles, then, are—as metallic bodies—tolerated by the living structures. To occlude a vessel, they require, as experience has amply

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[1] *Metallic bodies unirritating.*—See the "Edinburgh Medical and Surgical Journal" for January 1827, p. 197.

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shewn, to be retained for a few hours, or a few days at most; and further, when passed with this view across the mouth or tube of an artery, they merely place the internal surfaces of the vessel in close contact;—without isolating the vessel from its attachments;—without lacerating its two internal coats;—and without strangulating, ulcerating, and mortifying the constricted portion of the tube—all of which injuries and lesions are, as we have found, inevitably produced when the deligation of arteries is adopted. In thus using against hæmorrhage acupressure needles instead of ligatures, we attempt to bring all bleeding wounds in "general surgery" into the condition, as far as possible, of wounds in "plastic surgery," where union by the first intention is both the expected and the general result. We secure the bleeding arteries by unirritating metallic needles, and we withdraw them as soon as we can, so as to leave ultimately *no foreign body whatever* in the wound. Ligatures around arteries cannot be withdrawn for an indefinite period, or till—after several days or even weeks—they have ulcerated and sloughed through the tied vessel. We can at once remove, on the contrary, our acupressure needles always at will, and whenever we deem that they have produced their occluding effect. But I am forestalling some observations; for, before considering how short or long a time the needles should be left in, we have another matter than this to consider first—namely, how they are to be introduced and applied.

CHAPTER VI.

Apparatus required for Acupressure, and the Methods of applying it.

The instruments required for the employment of acupressure are of the simplest kind. They are chiefly applied in three modes. In the first method, the only instrument required is a long needle (Fig. 5) headed with glass or sealing-wax to allow of sufficient pressure upon it for its introduction ; in the second method, a short common sewing-needle (Fig. 6) threaded with iron-

Fig. 5.

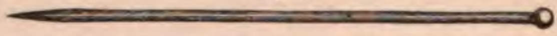

Fig. 5. Acupressure Needle. The form first used.

Fig. 6.

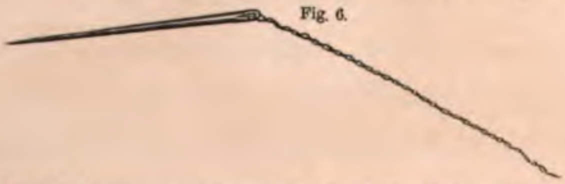

Fig. 6. A common sewing-needle, threaded with iron-wire, to be used as an acupressure needle.

wire or with silk; and in the third method, the same needle along with a loop of very slender passive iron-wire or thread (Fig. 7) of four or five inches in length. The three chief methods of applying the needles are as follows:-

Fig. 7.

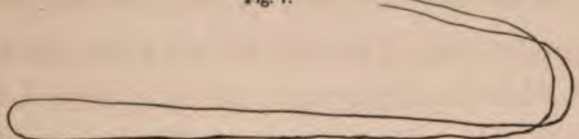

FIG. 7. Loop of iron-wire, to be used for compressing an artery against a common sewing-needle, according to the third method.

First Method of Application.

This was the mode which I generally adopted in most of the first acupressure operations. It consists in passing a long needle twice through the

Fig. 8.

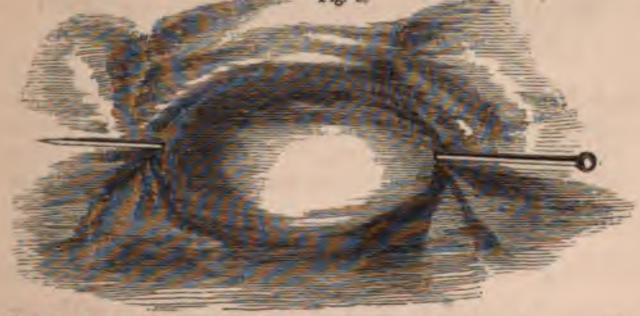

FIG. 8. Cutaneous surface of a flap, in which an artery is secured by an acupressure needle, according to the first method.

flaps or sides of a wound, so as to cross over and compress the mouth of the bleeding artery or its tube, just in the same way as in fastening a flower in the lapelle of our coat, we cross over and compress the stalk of it with the pin which fixes it, and with this view pass the pin twice through the lapelle. (See Figs. 8 and 9.) The only portion of the needle which is left exposed internally on the fresh surface of the wound (Fig. 9) is the small middle portion of it, which bridges over and compresses the arterial tube at its bleeding mouth, or a line or two or more on the cardiac side of it. And if it were a matter of any moment, this part

Fig. 9.

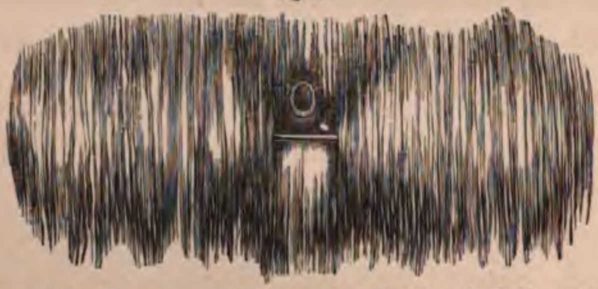

FIG. 9. Wound surface of the same flap, shewing the bridge of the acupressure needle compressing the artery. In this, and the woodcuts Figs. 10 and 11, the open mouth of the artery is represented as further removed from the needle than it perhaps generally is in practice.

need not always be left bare, for the needle could be often passed, a few lines higher up, *between* the vessel and the cut surface, and without emerging on that surface. More or less of both extremities of the needle, viz., its head and point, are exposed externally on the cutaneous surface of the side or flap of the wound (Fig. 8). When passing the needle in this method, the surgeon usually places the point of his left forefinger or of his thumb upon the mouth of the bleeding vessel, and with his right hand he introduces the needle from the cutaneous surface, and passes it right through the whole thickness of the flap till its point projects for a couple of lines or so from the surface of the wound, a little to the right side of the tube of the vessel. Then, by forcibly inclining the head of the needle towards his right, he brings the projecting portion of its point *firmly* down upon the site of the vessel, and after seeing that it thus quite shuts the artery, he makes it re-enter the flap as near as possible to the left side of the vessel, and pushes on the needle through the flesh till its point comes out again at the cutaneous surface. In this mode we use the cutaneous walls and component substance of the flap as a resisting medium, against which we compress and close the arterial tube. But in some wounds a neighbouring bone or other firm unyielding texture forms the best and readiest point of resistance against which to pin and compress the artery by the acupressure needle. In such cases, the end of the finger at the bleeding point is sometimes necessary to assist the needle in duly pressing it down upon or against the open vessel. In both those modifications of acupressure a thick flap, or a vessel situated deeply, requires a proportionally longer needle; and the amount of pressure upon the artery is easily regulated and increased, when required, by the acuteness of the angle which the needle makes in its passage over the arterial tube. The degree of compression required to shut an artery by acupressure is generally by no means great, especially if care be taken to pass the needle as near as possible to the arterial tube, and without a layer or layers of elastic tissue intervening between them. This needle can be withdrawn at will, at any hour or time, by pulling at the head of it; which, I have said, is placed externally.

There are some objections to using such long needles in acupressure when they can be avoided. They are liable to be passed so as to compress the included tissues too strongly; they compress, however slightly, an unnecessary extent of tissue; and, being partly external, they are liable to prove unwieldy and incommodious in putting on dressings, etc., to the wound, provided we do use such applications to it.

In the method of acupressure which I have described, the long needles are introduced from the cutaneous surface, and their extremities left out *externally*. In the two other methods—the second and third—common sewing-needles are used. They are introduced on the raw surface of the wound, and are situated thus altogether *internally*, or between the lips of the wound.

Second Method of Application.

A common short sewing-needle (Fig. 6),

threaded with a short piece of iron-wire for the purpose of afterwards retracting and removing it, is dipped down into the soft textures a little to one side of the vessel, then raised up and bridged over the artery, and then finally dipped down again, and thrust into the soft tissues on the other side of the vessel (Fig. 10). In bridging over the vessel, care must be taken to press the end of the needle down upon the mouth or tube of the bleeding artery with force sufficient to shut the arterial tube and arrest the hæmorrhage. The end of the finger pushed against the side of the projecting portion of the needle is often required thus to compress and close the

Fig. 10.

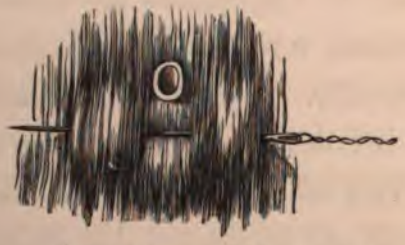

FIG. 10. Acupressure applied to an artery by means of a common sewing-needle. The second method of acupressure.

vessel adequately, before the tip of it is sent onwards and fixed in the tissues beyond.

Third Method of Application.

This method is the one which will probably be most frequently followed. It consists in compressing the vessel between the threaded sewing-needle (Fig. 6) and a duplicature of passive iron thread (Fig. 7). Here, as in the method last related, the cutaneous surface is left intact; but the needle is passed *below*, instead of over or above, the artery. The point of the needle is entered a few lines to one side of the vessel, then passed under or below it, and afterwards pushed on, so that the point again emerges a few lines beyond the vessel. The noose or duplicature of wire (Fig. 7) is next thrown over the point of the needle; then, after being carried across the mouth or site of the vessel, and passed around the eye-end of the needle, it is pulled sufficiently tight to close the vessel; and lastly it is fixed by making it turn by a half-twist or twist around the stem of the needle. A slight half-twist usually fixes a rigid wire-thread quite perfectly (Fig 11). If the operator prefers, he may keep the two threads of the noose open after they bridge across the artery, and *tie* them below or behind the eye-end of the needle, in the form of a common single or double knot. A common silk thread may be used in the same way. But the tie with any kind of thread takes much longer time than the twist with metallic thread, and certainly is not more efficient. When in either case—whether the twist or tie has been adopted — the operator wishes to remove this simple acupressure apparatus after a period of, say five, twenty, thirty, or more hours, all he has to do in order to withdraw the needle is to pull it out, by dragging at the twisted wire with which

Fig. 11.

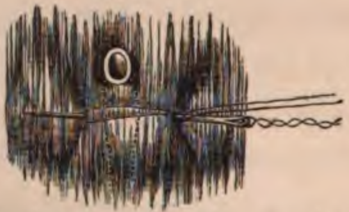

Fig. 11. The third method of acupressure, by means of a common sewing-needle and a loop of iron-wire, which embrace between them the arterial tube and some surrounding tissue.

it is threaded. The noose of wire-thread is thus at once loosened and liberated, and can be withdrawn. To distinguish easily between the wire-thread passed through the eye of the needle and the duplicature of wire, it is always convenient to mark the former by having it plaited or twisted, as represented in the woodcut, Fig. 6; or a knot for the same purpose can be tied on the end of it.

The mechanism of this third method of applying acupressure is not so easily described and delineated as the two first methods. Perhaps, however, a skeleton scheme or diagram of it, as given in Fig. 12, will make it more intelligible.

Fig. 12.

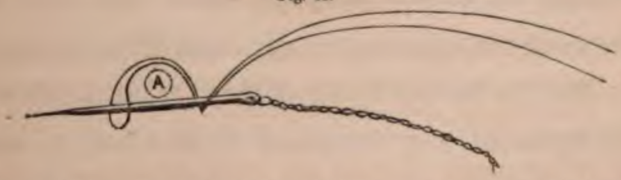

Fig. 12. Diagram of the third method, shewing the artery, A, placed for compression between the needle and thread, and the mode of fixing the iron thread by a half-twist around the eye-end of the needle.

In this scheme A represents the artery, which, with some surrounding tissue, is intended to be inclosed and compressed between the needle passed below it, and the wire passed over it. This diagram also shews the loop of the wire as thrown over the point-end of the needle; and it represents also that single twist of the wire around the eye-end of the threaded needle which is sufficient to fix it, and keep it fixed. For it must always be remembered, that in working with wire-thread a slight twist of it around another piece of wire-thread, or around any fixed body, as a needle, fixes and fastens it in the same way as a tie fixes and fastens a silk thread.

When either the second or third of the preceding methods is adopted, some little care is necessary in adjusting the direction of the needles, so that the threads by which they are ultimately to be retracted may be placed in or nearly in the same line with them. In other words, the thread which is to withdraw the needle, and which for that purpose is placed outside the lips of the wound, must—in order to accomplish this object easily and readily—be laid so as to be nearly on a line with the general direction of the needle inside the wound. And, in occasional instances, the direction in which the acupressure needle is originally introduced will perhaps betimes come to be in some degree regulated, in certain wounds, with a view that the iron threads with which they are threaded may protrude to the most dependent part, or to some other selected part of the wound.

In any of the three methods of acupressure described, it is quite possible that the surgeon, particularly if unaccustomed to use the needles, will fail in his first, or even in his second attempt to close the bleeding vessel; just as, in using the ligature, he occasionally fails, once or oftener, to catch the bleeding orifice with his artery forceps, or to secure it with his thread. But, in the one case as in the other, the repetition of the attempt, and a little experience, will soon enable him to overcome these minor difficulties.

Before inserting the acupressure needles, the seizure and traction of the bleeding arterial orifice is not, as a general rule, at all required. But, perhaps, in some instances, especially in wounds having a perpendicular surface—as in the anterior part of the stump in amputation below the knee—the needle will, when used in accordance with the second or third method of acupressure, be sometimes fixed more easily if the orifice of the vessel, whose tube it is intended to compress, be first caught with the forceps. We shall find, however, afterwards, that in this special amputation acupressure has already repeatedly succeeded in arresting the hæmorrhage, when the bleeding orifice was too retracted to be seized with either forceps or tenaculum.

Of the three methods of acupressure mentioned, the one which is the most certain, and which probably will be most frequently followed by practitioners, is the *third*, though at the same time it is the most complex of the three, as requiring the use of a thread in addition to that of a needle. When using this method the practitioner can pull with the loop of thread, so as to compress the artery between it and the needle with any increasing amount of power that may be necessary to occlude the vessel. In employing any of the methods, however, it must not be forgotten that a small amount of pressure, if only sufficient for the purpose, is no doubt safer and better than a very great amount of it. In acupressure, the steadiness of the compression is of more importance than the force of the compression. "The art of stopping hæmorrhagy by compression consists (according to Petit) less in the force that is used than in the *steadiness*[1] with which it is applied. The slight pressure of the finger alone is sufficient, if but the stump and the finger could be kept steady; nor is there anything required to make compression perfectly successful, but to invent a machine which shall perform the office of such a finger." This last indication is so far fulfilled in the employment and effects of acupressure.

Other, better, and simpler methods of employing acupressure as a hæmostatic agent will, in all probability, be yet discovered. Smaller needles and pins will perhaps be preferred by some for the purpose. Possibly a simple needle, used so as to take in, during its course, two or more stitches of tissue—one or both of the stitches including the tube of the bleeding artery—would be found to answer; or even a diminutive pin merely driven straight through the arterial canal, so as to compress its sides together; or a needle passed through or behind the vessel, and then turned more or less completely around it, so as to twist or contort its mouth or tube before the point of the instrument is fixed by being passed onward into the tissue beyond. In some of the first experiments made, I closed the arterial tube, which I wished to occlude, between two parallel needles introduced through the flaps or sides of the wound. I tried also a miniature fork or hair-pin of stiff iron wire, sharp at its extremities, pushing it into the walls of the wound in such a way as to embrace and close the bleeding artery by impacting it and the surrounding tissue into the contracted angle of the fork. For this purpose the small forked pin, or needle if I may so call it, was of such a shape that it became much and suddenly contracted at its upper or angled part. But all these instruments were found far less simple, and less efficacious, than the three methods of acupressure which I have described and figured in the earlier part of this chapter.

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[1] *Steadiness of pressure the object required.*—This account of Petit's statement is given by Mr. John Bell in his "Principles of Surgery," vol. i. p. 172. See Petit's more lengthened statement in his "Traité des Maladies Chirurgicales," tom. iii. p. 171.

CHAPTER VII.

TIME OF WITHDRAWAL OF THE NEEDLES—ILLUSTRATED BY CASES OF THE UNION OF AMPUTATION WOUNDS, ETC., BY THE FIRST INTENTION.

MUCH more investigation and practice are requisite before the proper period for the withdrawal of the needles, and some other questions regarding acupressure, can be definitely settled. We want, for example, a series of proper experiments and observations as to the actual pathological mechanism by which acupressure occludes the mouths and tubes of arteries, before we can attain fixed ideas as to its progress and completion.* We do not yet precisely know if under acupressure the approximated internal coats of the closed artery cohere with or without the medium of fibrin; and how much of the occlusion is owing to changes in the artery or its contents, immediately above the site of the needle; and how much is the result of plastic processes which occur around the external surface or tube of the obliterated vessel. Nor have we ascertained exactly how long a time any or all of these processes require for their development. But we know from clinical experience that a comparatively short time usually suffices for the practical occlusion of the acupressed artery; the period being varied by the size of the vessel. The largest arteries divided have been generally found closed within fifty hours; those of medium size in twenty or thirty hours; and those of small size sometimes within a couple of hours.

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* See Appendix IV.—Note on the pathological mechanism of the Closure of Arteries by Acupressure.

In proof of the preceding remarks, let me proceed to adduce a series of cases of amputation and other wounds in which acupressure was employed, and complete union by the first intention took place. Such cases, when given along with the date of the removal of the needles, will perhaps be considered of more interest and importance than any lengthened and didactic comments on the question of the proper date for the withdrawal of the acupressure needle. The cases themselves will also be found valuable as affording evidence of the possibility, under acupressure, of the entire union of amputation wounds of the limbs; a result which we have found one of the greatest of living surgeons, Professor Chelius of Heidelberg,[1] declaring to be a circumstance which "never takes place" under the former systems of surgical treatment.

The largest artery opened in operative wounds is the femoral. Out of a dozen or more cases of amputation of the thigh, in which the femoral artery has now been closed by acupressure, the needles occluding the principal artery have been removed at various times. Dr. Struthers of Leith was the first surgeon who had the boldness to apply acupressure to the femoral in an amputation of the thigh. In this case, the details of which will be given subsequently, Dr. Struthers did not remove the needle from the main artery till the fourth day, or about ninety-eight hours. Shortly afterwards, in a second successful amputation of the thigh, performed, as in Dr. Struthers' case, for traumatic spreading gangrene, Dr. Handyside removed the needle over the femoral vessel in forty-nine hours.

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[1] *Chelius.*—See the footnote in a preceding page (p. 21).

In the following case, reported to me by my friend and former pupil, Dr. Hamilton, the needle was removed from the femoral artery after forty-eight hours. The case occurred in the practice of a very able young surgeon—Mr. Brown of Carlisle.

Case I.—*Thigh Amputation and Primary Union—Needles Removed in Forty-eight Hours.*—The patient was a man of fifty years of age, and had suffered for two years from ulceration of the cartilages of his left knee-joint. Two sinuses connected with the joint were yielding a profuse discharge of very offensive pus. The poor man was reduced to such a state of emaciation and debility, that when he came down from the neighbourhood of Carlisle to Edinburgh for the purpose of submitting to amputation, one of our most distinguished surgeons refused to undertake the responsibility of operating. He therefore returned to Carlisle, where the amputation was undertaken by Mr. Brown, and performed at the lower third of the thigh. The amputation was made by Mr. Teale's method, or by two rectangular flaps. Five vessels bled, and required to be acupressed. Forty-eight hours after the operation all the needles were withdrawn. Primary union took place throughout, except at the opening through which the wires emerged, and a single spot where the canal of one of the old sinuses, already alluded to, had been cut across. Within five days of the operation, the union was complete from end to end except in the sinus. The patient was able to be dressed and down stairs within four weeks, and in six weeks he was driving out alone in his gig daily; his general health good, and his strength rapidly returning.

The preceding case is taken from an interesting series of nine or ten examples of the use of acupressure in the larger amputations, etc., kindly drawn up at my request by Dr. Hamilton, lately House-Surgeon to the Carlisle Hospital.[1] Out of the amputations which he details in his report, let me cite another instance of healing by the first intention.

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[1] *Cases reported by Dr. Hamilton.*—See the "Edinburgh Medical and Surgical Journal," January 1864, p. 630.

CASE II.—*Primary Union after Amputation below the Knee—Needle removed in Forty-eight Hours.*—A boy, of eleven years of age, was brought into the Carlisle Infirmary with compound comminuted fracture of the tibia and fibula, from two railway waggons having passed over his leg. Amputation was performed below the knee by Mr. Page, and the anterior tibial artery—the only vessel requiring interference—was secured by an acupressure needle. It was withdrawn after forty-eight hours. The flaps adhered by first intention from end to end.

Amputation of the leg leaves a wound which is generally not looked upon as very favourable for any great amount of primary union, as so very large a surface of bone is exposed in the division of the tibia and fibula. In the following instance of this operation for a pathological disease, performed by one of the ablest surgeons of the present day, Professor Keith of Aberdeen, complete union by the first intention followed.

Case III.—*Amputation of the Leg and Primary Union—Needles removed in Forty-eight Hours.*—The patient, a combmaker, æt. 14, was admitted into the Aberdeen Royal Infirmary on account of long-standing disease of the ankle-joint. The bones being found incurably disorganised, Dr. Keith performed amputation at the end of the middle third of the leg. Three arteries demanded surgical interference, and were each compressed between a needle and a loop of silver wire, applied according to the third method. At the end of forty-eight hours the needles and silver loops were withdrawn. The flaps united completely from end to end without any formation of pus.

Perhaps in the two last instances which I have adduced, the needles might possibly have been removed even earlier than they were; but it is of still higher importance to remark that their continuance for two days did not prevent primary union. In a case of amputation of the arm, in a girl of fifteen or sixteen years of age, which I witnessed some time ago, the needles were all withdrawn within twenty-two hours. The operation was done by Mr. Edwards, who has tried acupressure in more instances, I believe, than any other surgeon. But let me quote to you Mr. Edwards' own account of the case, which, to my view at least, at first looked a most unpromising case for recovery at all :—

CASE IV.—*Amputation of the Left Arm, and Needles removed in Twenty-two Hours.*—The patient had been suffering for two years under scrofulous disease of the elbow-joint, apparently set up by an injury. "Latterly (says Mr. Edwards) she had suffered severe pain, and moving the limb was scarcely possible. When I saw it, the elbow was packed in large, heavy poultices, the weight of which had, during some moment when the arm was left unsupported, broken the humerus about two inches above the joint. The fractured ends threatened to pierce the skin. The joint was evidently disorganised. She was not a favourable subject, being thin and feeble; a large swelling, apparently a chronic abscess, over the left side of the thorax; but she was suffering so acutely from the fractured arm, that I thought it my duty to amputate, which I accordingly did the next day, having to go close under the tuberosities, so as to secure tolerably healthy soft parts.

All the vessels, including the brachial, were secured with needles and wires by Professor Simpson; they effectually prevented hæmorrhage, and were all removed in twenty-two hours; the flaps adhered, and, except a little pouting at the skin margins, the stump was healed in five days; on the fourth she was out of bed, and was able to walk to my house on the eighth day."[1]

I have mentioned, in the four preceding instances, cases of amputation wounds where the vessels were acupressed, and healing of the stump followed by primary union. The cases in question were instances of amputation of the thigh, of the leg, and of the arm. As other instances of union by the first intention, let me select two examples of amputation of the forearm, one from the practice of Dr. Greig of Dundee, who was among the first surgeons that used acupressure; and a second from the practice of Dr. Henderson of Leith.

CASE V.—*Amputation of the Forearm for In-*

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[1] *Amputation of the left arm.*—See "Medical Times and Gazette," April 11, 1863, p. 385.

jury, and Needles removed within Two Days.—In a case of injury Dr. Greig performed amputation at the middle of the right forearm, and secured the bleeding vessels with ease and success by acupressure. Little or no local irritation followed, and the wound healed entirely by the first intention. This was the second case of amputation in which he employed acupressure. He removed the needles about the end of the second day. Dr. Greig, as one of the surgeons selected and sent out to the East during the Crimean war, as a diligent observer when a student, and as surgeon to the Dundee Hospital, has necessarily seen many amputations; but latterly he wrote me that this case formed the first amputation wound which he "had ever really seen close entirely by union by the first intention." "The stump (he adds) was a beautiful one, the ends of the bones being much better covered than they would otherwise have been had the wound healed by suppuration, and in proof of this I may mention, that although it is the right hand which was lost, the lad was very soon back at his work, which was that of a stone-mason, and able to hew as well as any of his companions."

Case VI.—*Primary Amputation of the Forearm, in an aged patient—Union by the First*

Intention.—"About a year ago (Dr. Henderson writes me) I had occasion to remove the greater part of the forearm from an old woman who had it very severely and extensively injured by machinery, and who was in such a weak state of health at the time of the accident, and had lost so much blood before the operation was commenced, as to make it almost certain she would die if she lost an ounce or two more during it, or if any large amount of suppuration took place from the wound after it. I considered the treatment by acupressure to be well suited for such a case, and used it with the most perfect success, as a much smaller quantity of blood than usual was lost on the occasion, and the wound healed *completely* by the first intention." Dr. Henderson informs me that the needles were withdrawn towards the end of the second day.

In answer to the question, At what time should the needles be withdrawn? there are one or two important replies, which, I think, we are already entitled to make:—

I. As a general rule, even such a large artery as the femoral will be found closed in forty-eight or fifty hours; whilst, on the other hand, the retention of the acupressure apparatus for that length of time does not exclude the possibility of complete union of the wound. For, apparently, the sides of the wound close in and around the metallic needle and threads without any such suppurative action being necessarily produced as occurs in the track of a long-retained silk or organic ligature.

II. The acupressure needles, in minor amputations and wounds, and when occluding minor vessels, may, without much detriment to the chances of primary union, be left, therefore, for forty or fifty hours. Probably, however, their earlier removal, if found—as I believe—possible and practicable, will add to the chances of union by the first intention; for the earlier all foreign bodies whatever are withdrawn from the wound, the greater, no doubt, are the chances of primary adhesion.

III. Two circumstances, let me add, appear to contra-indicate the early removal of the needles. (1.) If there is sickness and vomiting, consequent upon the operation, the acupressure apparatus should be left longer than usual, as the act of vomiting is sometimes attended by the recurrence of hæmorrhage. (2.) Again, in any doubtful case, the appearance or feeling of the pulsation of the principal artery or arteries up to the very edge of the wound, should make us cautious in withdrawing the needles. Till more practical knowledge is accumulated on the subject, it is at least better to err on the side of safety to the patient than to make too urgent efforts for complete primary union. Possibly even the retention of the needles for sixty, seventy, or more hours, may not be found incompatible with primary adhesion in some cases and constitutions.

IV. But perhaps, as I have often ventured to suggest, the time may come when, in minor operations and amputations, the surgeon will wait six or twelve hours before closing the lips of his wound by metallic sutures, and be able to withdraw, before he does so, most, if not all, of the acupressure needles which he has employed. If so, he would be able to close the sides of his wound without any foreign body whatever being left between them. In the following instance, my friend and former assistant, Dr. Coghill, now of Shanghae, acted successfully upon this principle.

Case VII.—*Excision of the Mamma—Needles removed in Two Hours.*—The patient was a very stout and bulky Highland woman. There was a large cancerous tumour in one of the mammæ. In removing it, Dr. Coghill was obliged to make a wound of eleven inches in length. Three or four vessels bled, and were occluded by acupressure needles. Dr. Coghill left the wound open for about two hours. Before closing it he removed the needles, without there following any appearance of hæmorrhage. He then, very carefully and accurately, brought together the lips of the wound with stitches of iron-thread. Complete and entire union by the first intention ensued.

In his admirable monograph on the "Diseases of the Breast," M. Velpeau has made, in reference to primary union of the wound after excision of the mamma, a few remarks, which are perhaps not uninteresting in regard to such a result as the above. In one part of his work, he speaks of having excised the mamma for cancer alone (independently of other non-malignant tumours) in 167 instances. These all occurred in hospital practice; and of course he has often operated in private practice also. Yet in only four or five instances has he observed the resulting wound to heal by the first intention; and in these few exceptional cases *no ligatures* happened to be required. Their accidental absence permitted, as it were, primary union to occur. "Should (to use Velpeau's own words) immediate re-union and complete cicatrization by the first intention occur, so that the wound closes without suppuration, we have every reason to be delighted; but this circumstance is so rare, that I have only witnessed it on four or five occasions, twice in men, three times in women; in all instances, after the removal of small tumours, and in patients who were somewhat thin, where there had been *no necessity for ligatures,* and where the wounds were perfectly even and of small extent. Except under these circumstances, I have usually found the wound to suppurate, so that it almost always required from three to five weeks before cicatrization was complete."[1]

In these four or five instances of apparently small mammary wounds, primary union was the result, probably, as I have already suggested, merely because it happened as a matter of accident that no arterial ligatures were necessary. In Dr. Coghill's case, the mammary wound was unusually long and large, and yet primary union was the result, because it was regulated as a matter of art that no ligatures were used, and that the wound was in a short period after its infliction closed, without any foreign body whatever being left lodged within its cavity or between its walls.

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[1] *Primary union after excision of the mamma.*—See Velpeau's "Treatise on the Diseases of the Breast;" Sydenham Soc. edit., pp. 509 and 528.

CHAPTER VIII.

LOCAL REQUISITES FOR THE PRIMARY UNION OF WOUNDS.

IN the last chapter I have described several instances of the larger amputations—that is, of the thigh, leg, arm, and forearm—in which acupressure was used, and complete union by the first intention took place in the resulting wounds. In relation to the immediate and primary union of amputation-wounds, they form a series of cases which, up to the present time, is, I believe, as yet unique in surgery. At the same time, under the more extended use of acupressure, the complete primary union of amputation-wounds will, I have no doubt, become more common.

Such cases as I have cited in the last chapter might possibly lead some readers to imagine that in the way of the local management of wounds, acupressure was all that was requisite to ensure that desirable object—union by the first intention. Any such inference, however, would be most erroneous. The primary closure of extensive wounds in which acupressure is used to arrest the attendant hæmorrhage, is still the exception and not the rule. It is one of the elements—and, as I believe, a most important and most necessary element—in our attempts to effect primary union; but there are other conditions and circumstances which must also be very carefully attended to before we can hope to attain on a large scale so very desirable an end. In attempting to enumerate the chief of these conditions and circumstances, I will advert only to those required in the primary management of the wound, or for the attainment of union by the first intention. The treatment of wounds healing by the second intention—or by suppuration, granulation, and cicatrization—is beyond the scope of the present essay.

(1.) *Union of the Lips of Wounds by Sutures.*—When the lips of wounds are brought together with the object of uniting them by primary adhesion, they are seldom in modern surgery attempted to be held and kept together by bandages, plasters, and external agglutinative applications, as collodion,[1] solutions of gutta-percha, caoutchouc, etc., except where the wound is of a superficial character. In wounds of any considerable extent, bandages and plasters do not readily bring and keep the opposed cut surfaces in accurate coaptation, particularly in their deeper parts; nor do they afford the steadiness and security of coalescence between these surfaces that are indispensably necessary for the success of union by the first intention. Hence in all wounds—except those of a slight and superficial kind—which are intended to unite by primary adhesion, almost all modern surgeons bring and retain the cut edges together by means of sutures or stitches.

(2.) *Suture-threads—Metallic preferable to Organic.*—The suture-threads employed are either organic or metallic. The metallic consist of very slender capillary wires or threads; the organic are usually composed of silk, hemp, flax, or the like. I am not aware that the latter or organic threads have, as suture-threads, any single advantage of any kind over metallic threads; while, on the contrary, metallic threads have—from their relatively unirritating qualities, the length of time which they may safely be left embedded in living tissues, and the steadiness with which they keep the edges of a wound in contact—most decided and most important advantages over organic threads. If the suture-threads are to be removed within two or three days at most—as in the wounds in ovariotomy, cæsarian section, and in other similar wounds, where there is no marked tendency to the tension and separation of the edges—it perhaps is a matter of no great moment whether the material of the stitches be metallic or organic; for no form of thread usually produces much local or special irritation upon the neighbouring parts during the first fifty or sixty hours of its insertion. Generally, however, about that time

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[1] *Collodion, solutions of gutta-percha, etc.*—In the Edinburgh "Monthly Journal of Medical Science" for July 1848, p. 49, I have described the application of solutions of gun-cotton, gutta-percha, etc., to the cohesion of the lips of wounds. See note in Appendix No. V. on this subject.

—and frequently earlier—the animal fluids which organic threads have imbibed from the surrounding tissues begin to decompose and putrefy; and, in consequence, these threads, like slender or miniature setons, produce in their immediate vicinity more or less marked irritation, which, for the most part, rapidly increases. A metallic thread, on the contrary, is incapable of imbibing any fluid, and consequently is incapable of producing any poisonous irritation of this kind. Hence it follows, that if the stitches are to be retained more than two or three days, metallic suture-threads, as being infinitely less irritating, are to be decidedly preferred. In few wounds, perhaps, will it be found necessary in practice to retain suture-threads beyond the fourth or fifth day at most, though it has become a rule with some operators to leave in the metallic threads in cases of vesico-vaginal fistula for eight or nine days. Various authors have used threads of various metals. Long ago threads of lead were employed by Percy, Dieffenbach, and Mettauer, in some plastic operations. Mr. Gossett of London recommended "gilt wire," in 1834, for plastic and all other wounds. Mr. Morgan, surgeon of Guy's Hospital, London, about 1840–41, stitched all his wounds with slender platinum wire. In 1858 Dr. Marion Sims, in a remarkable essay on the subject, called the special attention of the surgical profession to the advantages of silver sutures, a material now used to a considerable extent by operators in this country. I believe that very slender threads, made of iron, are the cheapest, strongest, and best for the purpose. They must be made of the "passive" iron of Schönbein, to prevent any oxidation of their surface. I have used iron suture-threads in a great number of cases in the operation for vesico-vaginal fistula, and with such almost invariable success in the way of effecting complete primary union, that I have no desire to change.[1]

(3.) *The Stitches should be planted deep.*—The mere shallow cutaneous edges only of large wounds are usually brought together by the superficial stitches that are used. But if the stitches be made by metallic sutures, they ought to be planted so deep and broad as to embrace the wound to the extent of half an inch or more on each side. Such wide stitches irritate the adhering surfaces of the wound less than narrow and shallow superficial sutures, because they are further removed from these surfaces: and, in addition, by their depth they place and keep the sides of the wound in more complete coaptation. In the intervals between these deep stitches, intermediate shallow stitches are generally required to bring the cutaneous edges of the wound into perfect and accurate contact. (See the diagram of the stitches in woodcut, Fig. 13, p. 98.) If the deeper and greater stitches which I have described are placed at the distance from each other of an inch or less, one or two such intermediate superficial stitches are usually necessary in each interspace to bring the cutaneous surfaces into full and perfect cohesion. In some modern surgical works, the width advised between individual stitches is such as to give up at once all hope of complete primary union. Thus, in a late work on Operative Surgery, a distinguished London hospital-surgeon advises, that "in wounds of the trunk and limbs, and also in amputations, two or three sutures are sufficient;" and he subsequently adds that "the precision and exactness of the union is comparatively of little moment."

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[1] *Sutures of metallic wire or thread.*—See APPENDIX, No. II., for a full history and discussion of them.

(4.) *Means of passing Metallic Suture-threads.* —Where metallic threads of iron, silver, etc., are employed to stitch together the sides of a wound, the wire used must be quite smooth, and without any knot or hitch upon it. Some surgeons, as Dr. Marion Sims and Dr. Bozeman, appear to have encountered such occasional difficulties in passing metallic threads through the lips of vesico-vaginal fistulæ, etc., that they adopted the practice of first passing a series of silk ligatures. They then fastened to the end of each silk thread a metallic thread, and ultimately pulled through the metallic thread by dragging at its silken precursor. This clumsy and complex mode of introducing metallic threads is now no longer required, as various forms of needles have been invented for facilitating and simplifying the process. In sewing together the lips of vesico-vaginal fistulæ, I have been for several years in the habit of employing a long tubular needle,[1] attached to a fixed handle, as was first suggested by Mr. Startin. This tubular needle serves equally well for bringing together the lips of most other wounds. In general forms of wounds, I have far more frequently, however, employed the common long and handled needle used in the transfixion and tying of nævi, internal hæmorrhoids, etc., and having an eye near its point.[2] Where this needle is employed for the transit of metallic threads, the two lips of the wound should be simultaneously transfixed by it, and *after* its point has emerged as far as the perforating eye, the end of the wire is slipped through the eye to the extent of a few lines. The needle is immediately and totally withdrawn by pulling at its handle; and in doing so the metallic thread is pulled through and placed *in situ*. This long and handled needle presents great advantages in enabling us to make easily and correctly the deep and broad stitches spoken of in the last paragraph (No. 3), as the two transfixed edges of the wound are placed upon the needle, and seen to be adjusted accurately to each other, before the thread is transmitted through them; and it is equally of use in passing the most delicate sutures. To render the entrance and transit of the metallic thread more secure, it may be bent up into a loop after being passed through the eye of the needle; but in reality this is not required in practice, as the wire is so slender and pliable as readily to mould itself to the shape of the orifice through which it is retracted when the instrument is being withdrawn. There is little or no danger of making the perforation too large, either by this plan, or by otherwise using a thick needle; for in introducing either metallic or organic threads, the mere size of the passage made by the needle and thread does not require to be taken into account in relation to the primary union of the wound, as all perforated openings of moderate size contract and close with almost equal readiness. Sometimes, in passing a metallic thread in a contracted part, as in a longitudinal wound of the vagina, etc., it will be found that a needle of the above construction, but turned at right angles to the shank, at the distance of an inch or an inch and a half from the point, answers extremely well. That terminal part of the needle which is placed at right angles requires to be made of a curved form. The common short and slightly curved surgical sewing needle is used by some practitioners for the introduction of metallic threads; but in order to facilitate the process, the shoulders of the needle require to be somewhat broader, and the grooves at its eye-end somewhat deeper than usual; and various new contrivances have been invented in order that the metallic thread may make its transit readily and easily. The wire thread is, from its stiffness, liable to make, at the eye of the needle, a roundish projection which impedes its passage, and sometimes it turns and forms an obstructive angle with the line of the needle. These difficulties have been got over by various modifications of the common surgical needle, suggested by Professor Lister,[1] Dr. Gustavus Murray,[2] Mr. P. C. Price,[3] Dr. Levis of Philadelphia,[1] Dr. Christen Smith of Christiania,[2] and others. My friend Dr. Aveling has proposed to

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[1] *Tubular or hollow needle.*—See a sketch of it in my Clinical Lectures on Diseases of Women in "Medical Times and Gazette" for Jan. 1859, p. 26; and Mr. Baker Brown's treatise on the "Surgical Diseases of Women," 2d edit. p. 127.

[2] *Handled or nævus needle.*—See figures of it in various surgical works, as in Fergusson's "System of Practical Surgery," 4th edit., p. 41; Miller's "System of Surgery," p. 470, etc.

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[1] *Professor Lister's needle.*—It is like an ordinary short surgical needle, but it is grooved at each side from the eye to the blunt end—these points being, moreover, at a greater distance from each other than usual. Care must be taken to hold the wire in the grooves while twisting its ends together, after which it will be found, says Mr. Lister, securely incorporated with the needle (see Holmes' "System of Surgery," vol. iii. p. 70).

[2] *Dr. Murray's needle.*—The blunt end, instead of being perforated by an eye, contains a conical canal, which lies in the long axis of the needle. The larger extremity of the canal is next the point of the needle, and has a longitudinal slit cut out of it: or, in other words, the canal commences as a wide groove, while its smaller extremity opens at the heel of the needle, and forms a complete tube. The end of the wire, after being entered at the narrow extremity of the canal—that is, at the heel of the needle—is brought through the above-mentioned slit, and then doubled back upon itself, and firmly pressed into the deep groove or upper extremity of the canal, so as to prevent the wire from escaping, while at the same time it offers no impediment to the passage of the needle (see the "Lancet" for May 1859, p. 514).

[3] *Mr. Price's needle.*—This modification of the suture-needle very much resembles Mr. Lister's in form. The grooved portion, however, comprises about a third of the length of the needle, and has *two* eyes or perforations, which should be round instead of being oblong, and placed about a quarter of an inch apart. The

end of the wire is first inserted into the eye furthest from the point of the needle, and then passed on and brought about an eighth of an inch through the other. This short projecting piece of wire is finally bent back and pressed into one of the two grooves. With the common needles, according to Mr. Price, the wire is very apt to become twisted and distorted, an occurrence which, he believes, is obviated by his contrivance (see the "Lancet" for June 1859, p. 572).

[1] *Dr. Levis' needle.*—A groove, deep enough for the lodgment of the wire, encircles the needle obliquely, near its blunt extremity, and leads into another groove which is vertical. This vertical or longitudinal groove is continued on to the very heel of the needle, and is intended for accommodating the doubled wire, but at its entrance is only wide enough to admit the introduction of one wire at a time. A loop of wire is placed in the circular groove, and its body and doubled back extremity are laid in the vertical groove, and twisted together. An attachment is thus formed, which Dr. Levis says is as firm as if the needle and wire formed one continuous piece: and the wire, being entirely incased within the grooves, will traverse any tissue of the body without any impediment. When ordinary or even grooved needles are used, the wire will form, Dr. Levis further avers, a ring-like attachment which impedes its passage. Also, a sort of hinge-joint is formed at the junction, which will be movable, no matter how tightly the wire is twisted, and will be continually forming an angle with the needle, and impeding its progress (see "Braithwaite's Retrospect of Medicine"—Part I. for 1860, p. 376; and "North American Review," Jan. 1860, p. 176).

[2] *Dr. Smith's needle.*—The blunt end has no eye, but has a

re-introduce an old plan of Fabricius ab Aquapendente, and use a strongish steel wire, hardened and sharpened at one end, as at once both a needle to sew with, and then a thread to tie with.[1]

(5.) *Modes of fastening Metallic Suture-threads.*—Metallic suture-threads may be fastened either by a double knot, in the way that silk threads are usually fixed, and as shown in the scheme Fig. 13, *a*; or by tying upon them a single knot and adding a twist or two in addition to keep the thread from slipping (see Fig. 13, *b*); or by first crossing and then twisting their extremities two or three times without any knot (see Fig. 13, *c*). If either of the two last methods be employed, and the ends of the suture are left long enough, the twisted part may—if

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canal drilled in it lengthways for about half an inch. This canal is narrowest at the heel of the needle, and is slit up at each side for about half its length. For the purpose of holding the wire more firmly, the interior of the canal is grooved transversely. The wires Dr. Smith uses are made of silver or tin, and, to facilitate introduction, are slightly sharpened at one extremity.

[1] *Needle-suture of Fabricius.* — See account of it in "Medical Times and Gazette," Jan. and April 1859, pp. 82 and 377.

necessitated by the swelling of the lips of the wound, on the second or third day—be loosened,

Fig. 13.

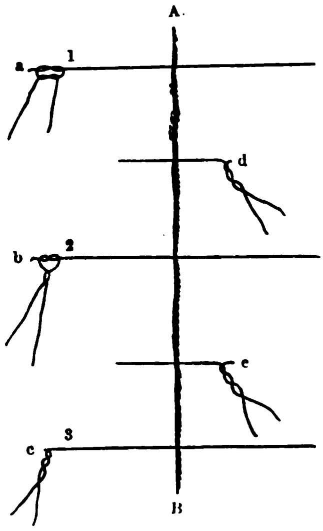

Fig. 13. Diagram representing in its vertical lines, A B, a portion of a wound stitched together by broad and deep stitches *a*, *b*, *c*, and shallow intermediate stitches, *d e*. In both forms of stitches the knots are all placed laterally or away from the line of the wound. The forms of knots with the metallic threads are represented at *a* by a common double knot; at *b* as a single knot, followed and fixed by a twist on the wire; and at *c*, *d*, and *e* as consisting of double or triple twists only. To show the forms of these various knots and fixtures, the wires at these points are represented as still loose and open, and not drawn so tight as is done in practice. The figures 1, 2, and 3, show the points at which the wires may be clipped, in order to slacken the ligature.

slackened, and then again re-twisted. But this is seldom necessary, provided the stitches are not drawn too tight at first. In order to avoid, as far as possible, irritation and pressure upon the immediate line of the cohering wound (Fig. 13, A B), the fastening knots or twists should always be made on one or other side of that line, as represented in the diagram. When this is attended to, the division or clipping of the metallic stitch on the long side of the knot or twist, or in other words *between* the knot and the wound (as at 1, 2, and 3 of Fig. 13) is usually sufficient to relieve any morbid tension which any individual stitch may appear to produce on the second or third day. The stitch is in this way readily slackened without its support being entirely withdrawn; for the rigidity of the freed and unknotted end of the wire-thread usually enables it still to maintain more or less its position and its support to the lips of the wound. If there is any fear of the unknotted end slipping down into the tissue, so as to loosen the stitch entirely, this effect can be prevented by making a slight twist or loop with the dressing-forceps on this end of the wire-thread.

(6.) *Necessity of perfect Coaptation of Lips and*

Sides of Wounds.—If we expect primary union, the sides or flaps of the wound, when brought together by the suture-threads, must never be of a kind to require pulling and traction, either to bring them into apposition or to maintain them in apposition. If they are too small or too short for this purpose, and if the stitches holding them require to be put or to be kept on the stretch, then union by the first intention becomes scarcely possible. Surgeons will probably come yet to shape all their incisions and flaps far more systematically than they do even at present, so that the sides and edges of their resulting wounds may lie fully, freely, and easily in contact. If this is not the case in any particular instance, or at any particular point, then certainly it is better to re-shape or reduce the fleshy sides or flaps so as to attain this most desirable and necessary object. How frequently in flap amputations, for instance, does the amount of muscular tissue left prevent the accurate adaptation of the cutaneous surfaces without such an amount of tension and dragging as almost inevitably prevents union by the first intention; and, indeed, the swelling of the exuberant muscular tissue within often enough comes to tear open more or less the distended surface of the wound. Under such circumstances it is surely infinitely better, before closing the wound at all, to pare down and remove, with knife or scissors, any such exuberance of muscular or other tissue. It is a far higher principle to operate against the failure of primary union than merely to operate against time, or for any vain purposes of apparent dexterity and display; for the true science of a surgeon is to be measured not by the rapidity with which he makes his cuts, but by the rapidity—and the safety too—with which he effects his cures. All the opposed points, throughout the depths of the wound, must be placed in accurate contact, and all the opposed points of the cutaneous surface also. After the stitches are introduced, great care—which is perhaps too often neglected—should be employed in fixing them, so as to bring into perfect and accurate contact the opposed points of the cutaneous tissue. Yet, with a little trouble and time, and sometimes by the aid of a probe or the end of the handle of a scalpel, this accurate adjustment of the two cut cutaneous surfaces[1] to each other can be readily and effectually managed.

(7.) *The Sutures not to be drawn over-tight.*—If the sutures, whether metallic or silken, be placed upon the strain, they will cut through the lips of the wound by ulceration to the extent necessary to relieve the strain. When the lips of the wound are ultimately adjusted, and accurately and carefully fitted to each other, no one of the sutures must be found on the stretch and deeply indenting or pitting the points on which it rests and presses; for, if so, the tracks of such over-strained threads will soon become the sites of irritation, ulceration, and suppuration, and the act of primary union will be more or less interfered with. Even should the suture-thread be metallic,

Accurate adjustment of the two cutaneous surfaces of wounds.—"In this conjunction," to quote the words of an old author, "equalitie must be observed. So the superficies of the one part of the wound must *exquisitly* answer the superficies of the other part; and there must be a due correspondencie betweene the inner sides."—(Alexander Read's "Treatise of Wounds," 1638, p. 48.)

if it be made to press too strongly or too long on any given point of living tissue, that point will certainly ulcerate. But the ulceration, under these circumstances, is not the result of the pressure of the metal thread, as metal; but it is the result of the *pressure* of the metallic thread simply as *pressure*, morbidly excessive in its amount. And any similar degree of linear pressure, in any other mode whatever, will produce the same ulcerative appearances. To avoid and avert any such over-pressure, at any special point where metallic threads are used, it is always a salutary expedient to mould or flatten by slight pressure with the finger the metal thread after it is knotted, or twisted, or fastened, so that it should be completely adjusted to the shape of the part in which it is embedded.

(8.) *The Wound to be cleared of all Dead and Foreign Materials.*—But still more, when we strive for primary union, must we beware of leaving any foreign and dead materials—however small and almost molecular they may be—on the sides or in the cavity of the wound. In an amputation-wound, when the saw divides the bones, the resulting dead particles of bone-dust are freely scattered and powdered all around. Any of these particles left on the surface of the wound would infallibly prevent primary adhesion at the points where they were lodged; nay, they would sooner or later set up suppurative inflammation ere they were finally discharged. They must all be carefully removed by the use of the wetted sponge; but let us not in turn forget that our sponges sometimes leave flakes and fragments of their tissue upon the surface of the wound, which, though they be minute, are still dead foreign bodies. Perhaps it may be found that metallic spatulæ of different forms cleanse the surfaces of most wounds from blood, etc., as readily as sponges, or even more so, whilst their use is free from the objection stated. After all, however, the most simple and certain method of clearing amputation and most other wounds from the presence of foreign materials consists in allowing a stream or series of streams of water to be run over their raw surfaces, so that these surfaces be thoroughly cleansed from all foreign bodies immediately before their ultimate closure. This most important rule is perhaps far too often neglected.

(9.) *Cessation of Hæmorrhage, and Time of Closure of Wound.*—Of course, it is needless to close up a wound and expect it to heal by primary union if coagula of blood are allowed to remain lodged within it. For these coagula are liable to act again as foreign bodies, both preventing present adhesion, and producing future suppuration. The wound must not be shut up till all bleeding has ceased; and it is well known that, in order to prevent the mischance of any coagula of blood or collections of fluid forming for the next few hours, some surgeons do not close their wounds till six, eight, or more hours have elapsed. No sufficient observations have been yet made in surgical pathology to ascertain the general length of time that a wound may be left unclosed without destroying the chances of primary union, nor how much the ratio of these chances is affected by the ratio of the duration of the non-closure of the wound. Yet the subject is practically a very important one. Does primary adhesion occur more surely when, as is generally imagined, the lips of the wound are brought together immediately after the operation? or is it more certain, as some seem to suppose, when this union is delayed for a few hours? and how many hours? I have seen, in a case of removal of the mamma, primary adhesion perfectly fail at all points when the lips of the wound were not brought together till twenty-four hours after the operation; and yet, in the same wound, the same adhesion perfectly succeed at those points where the union was secured by stitches on the day of the operation. On the other hand, I have known the wound made in vaginal lithotomy in the human female not allowed to be closed for twenty-fours after the operation, and yet unite entirely by the first intention.

(10.) *Duration and Management of Sero-sanguinolent Oozing.*—In some wounds, particularly of a large kind, a serous or rather sero-sanguinolent exudation or oozing takes place for some time after the operation. The fact is well known to surgeons as the cause of the red staining of their dressings; but few of them condescend upon the general duration of this discharge. Velpeau speaks of this exudation as rarely wanting "during the first or second day"[1] after operations, and soiling the dressing, the napkins, and sometimes even the whole thickness of the pillows. Professor Lister remarks, that this discharge, which he considers to be the serum of the liquor sanguinis, "soaks the dressing during the first twenty-four hours."[2] According to Mr. Syme, on the other hand, the discharge ceases "from eight to twelve hours after the wound is inflicted."[3] If the practice, therefore, be followed, of not closing the wound before that time has elapsed, then the reddish secretion or exudation will have terminated. If any quantity of it become locked up and accumulated between the lips of the wound, it will act there as a foreign body, so far preventing their apposition, and consequently their adhesion at the point of collection.

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[1] *Velpeau*—See his "Médecine Opératoire," tom. i. p. 349.

[2] *Lister*.—See his article on amputation in Holmes' "System of Surgery," vol. iii. p. 64.

[3] *Syme*.—"Principles of Surgery," 1863, p. 40.

I have heard it argued that ligature-threads are of use as forming tracks along which this fluid may escape. If so, then the tracks of the metallic needle and thread used in acupressure must also perform exactly the same function; but with this great difference in their favour, that being usually removed in from ten or twenty, to forty or fifty hours after the operation, they are not retained, like the ligatures, as foreign bodies, for a period much beyond that which suffices to serve for the supposed function of conduits. Some of the older surgeons washed the surfaces of their wounds, before closing them, with turpentine, alcohol, etc., using these fluids apparently for the purpose both of restraining immediate hæmorrhage from the smaller arteries and veins, and preventing all subsequent red effusion and oozing. They averred that primary union was promoted also by such stimulating applications. I have seen the fluids named freely applied in very large wounds, oozing apparently suppressed by them, and primary union follow; but perhaps the fortunate results were as much in despite of the use of these applications as from their use. It may be that some hæmostatic fluids, either liquid or aëriform, will yet be found, capable of restraining minor discharges and oozings, and promoting primary union; but at present the best application of the kind that we know of is, as I have already said, an abundant douche of water passed over the wound before its ultimate closure.

(11.) *The Wound to be formed so as to avoid the Retention of Fluids.*—When aiming at the union of any operative wound by the first intention, due care should always be taken to shape the wound in such a way as to avoid the mischance of blood, or of serous or other fluids, collecting in the cavity or between the lips of the wound. In other words, the position in which the patient's body is to lie during the few days succeeding the operation is to be taken into account, and the wound in consequence so shaped and directed that its lowest and most dependent part gives perfectly free egress to any fluid that may tend to accumulate within it. It is better and safer freely to divide the skin at this dependent part for an additional inch or more, than run the risk, from its non-division, of any accumulation of fluid in the cellular tissue there, or in the lower part of the wound. In making these remarks, I have a special view to the removal of mammary and other tumours. In dissecting out a diseased mamma, I have sometimes observed the wound at its dependent part left deeper within than without—a condition that almost inevitably ends in the failure of primary adhesion in the lowest part of the wound, and too often also throughout the rest of it. When, after the removal of the mamma, the resulting gash was of such a form that no mere extension of the lower end of it would make a dependent opening, I have seen again the bistoury thrust through the skin and cellular tissue at the lowest edge of the internal wound, with the result that the small but sufficient vent obtained by this perforation prevented all accumulation of fluid within, and led to union of the whole wound by the first intention. The same object—namely, the prevention of the mischance of the accumulation of fluids between the lips of wounds—is now attained in amputations when particular methods of dismemberment are followed. For example, in Mr. Teale's method of amputation by double rectangular flaps, the free exit of all fluids from the interior of the stump is so far secured by the resulting wound always having a dependent position. Professor Bouisson of Montpellier some years ago recommended that in amputation and other wounds the arterial ligatures, instead of being allowed to traverse the interior and mouth of the wound, should be separately brought out through the substance of the flap. After each ligature is tied, he attaches a needle to its free extremity, and carries it straight through the tissues from the point of application to the nearest point of the cutaneous surface.[1] By this proceeding he expects to promote the chances of primary union between the lips of the wound, seeing these lips are thus not, as usual, kept separate and irritated at any point or points by the presence of the arterial ligatures. If either the collected ligature-threads of a wound, or its acupressure-wires, were brought in this way through one suitable dependent perforation in the sides or flaps of the wound, a transit might sometimes be gained for any oozing discharge, and the chances of primary union in the lips themselves so far promoted.

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[1] *Bouisson.*—See his "Tribut à la Chirurgie," tom. i. p. 447.

(12.) *The Inclosure of Air to be avoided.*—In closing large wounds, particularly large amputation-wounds, it is further, I am inclined to believe, a matter of great moment to bring the flaps most carefully together from below upwards, so as to preclude the possibility of a small collection or collections of atmospheric air being left in the depths or between the approximated sides of the wound. I fancy that I have seen the flaps brought together first, and chiefly along their edges, so that a quantity or quantities of air were left lodged within. Like any other foreign body which keeps the opposed walls of the wound from approximating and touching perfectly, air, even in small quantities and bubbles, will as effectually prevent primary adhesion at the parts or points at which it is located as the same bulk of dead solid materials would.

(13.) *The maintenance of the Coaptation of the Sides of the Wound.*—Whilst it is thus a great and indispensable indication, to free the surfaces of the wound from all foreign matters that can possibly prevent them from coming everywhere and at every point into close and accurate contact, it is sometimes necessary, also, by the position and muscular rest of the wounded part—by the use, if requisite, of slight bandages—and by supporting sponges or light pads placed externally—to retain the opposed surfaces in the same close contact till they are glued together with sufficient strength. In other words, it is necessary, not only to place the sides of wounds in accurate contact, but it is necessary also to *keep* them thus in accurate apposition. The attainment of this object is greatly promoted by using sutures or stitches of sufficient extent; and if the stitches be made by metallic sutures planted so broad and deep as to embrace the sides of the wound to the amount of half an inch or more, bandages, plasters, and dressings are very seldom required. The mere atmospheric pressure keeps the sides of a wound in contact when once its lips are accurately closed and sealed up with an adequate number of metallic sutures.

(14.) *The necessity of Absolute Rest.*—When a wound is desired to be healed by the first intention, the next great indication after its perfect closure is rest—*perfect rest.* All kinds of movement of the part, alike by the patient and by the surgeon, must, as far as possible, be avoided. For the first hours, or even for the first days, after its sides are placed in apposition, the plastic adhesions between the opposite surfaces of the wound are so delicate and so friable as to be easily damaged and broken up by motion or pressure; and any disturbance or rupture of these adhesions, at a point however limited, is liable to spread its irritation to the neighbouring parts. Any movement, or lifting of the stump for the inspection of the wound, or any pressure upon it by the fingers of the surgeon or nurse, is ever apt to produce slight and yet disastrous lacerations between some parts of the adherent surfaces. Hence, for some days, all touching and fingering of the sides or vicinities of recent wounds should, as far as possible, be strictly avoided and forbidden. In examining the wound, the surgeon should use his eyes as much as is necessary, but not his fingers. He may look at it, but not touch it; inspect it, but not move nor handle it. The plastic processes of nature in the healing of many a wound have been upset by the neglect of this simple and all-important principle. In the treatment of fractures every practical surgeon acknowledges and strictly acts upon the law of enforcing absolute rest, in order to ensure the re-union of the divided bones. The same practical principle is of as great importance in the re-union of soft as of hard parts—of flesh-wounds as of bone-wounds. The meddlesome dressing of wounds, as still practised by many surgeons, sets this principle utterly at defiance—more particularly when followed, as it is by some, daily, and with much muscular movement and handling of the wounded limb or part. Yet there are few facts more certain in surgery than this, that the local dressings commonly applied to large wounds are not only utterly unnecessary, but truly injurious.

(15.) *The general Inutility of Dressings.*—The fewer local dressings and applications we require to place about a wound, the greater, indeed, is the chance of its successful repair and immediate reunion. I believe, in other words, that, after the sides and edges of a wound are properly approximated and adjusted with its metallic stitches, the best dressing, as a general rule, is—nothing, absolutely nothing. I have seen full and testing proof of this in the large wounds left by excision of the mamma, in ovariotomy, in operations for ruptured perineum, etc. We have not easily the power of applying any dressings, or ointments, or lotions, to cases of vesico-vaginal fistula, immediately after they are operated upon; and it is, perhaps, fortunate that it is so; for, probably, these vesico-vaginal wounds close by primary union with the comparative certainty and in the large proportion which we see in practice, greatly because we are shut out from intermeddling with them, therapeutically or surgically, after they are once stitched up. We cannot overload and overheat them, as was too often done in former times, in dressing external wounds with complex layers of ointments, pledgets, straps, rollers, crosses, caps, etc. Even a dressing of charpie and cold water to a recent wound is, perhaps, more hurtful than useful. It busily unmakes what nature is busily making—a crust along the edges of the closed wound. If the lips of it threaten to become red and irritated or inflamed, then we may apply to them cold water, or still better, cold air. I have found that occasional streams of cold air directed upon the wound or its vicinity from a pair of bellows prove both most beneficial locally, in keeping down morbid heat and irritation, and are most grateful to the feelings of the patient.[1] When the surface of the wound is thus left uncovered, we have an opportunity of at once ascertaining the accession of redness or swelling in any part of it, and of relaxing or snipping any particular suture-thread that may be offering to produce traction or irritation. We can do this without putting the patients to the annoyance and pain of forcibly lifting or raising the dressings from the site of the recent and tender wound—entangled, as these dressings are always apt to be, with the ends of the ligature-threads, and with dried discharges gluing them to the newly-cut surface. This absence of all coverings further frees their thoughts from the dread of the renewal and changing of the dressings themselves from time to time—a source of terror of which some patients, as M. Velpeau correctly observes, are almost as afraid as they are of the operation itself.[1] The abandonment of all dressings whatever saves the patient, I repeat, alike from any sufferings and from any fears attached to the removal of them.

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[1] *Cold air as a local application.*—The sedative effects of a stream of cold air upon an inflamed part are well exhibited under other circumstances also, as in some forms of scalds, burning, etc., when occasionally its influence proves most beneficial and soothing. Carbonic acid gas is still more decidedly anæsthetic in its local application to abraded and wounded surfaces of the body. See Note in APPENDIX No. VI., on the anæsthetic and healing effects of carbonic acid when applied to open ulcers and wounds.

[1] *Velpeau.*—See his "Médecine Opératoire," tom. i. p. 343.

CHAPTER IX.

RETROSPECTIVE NOTICES OF THE PRIMARY LOCAL DRESSING OF WOUNDS.

IN the history of surgery few things are more strange than the revolutions that have taken place in the local primary treatment of wounds. In Greek, Roman, Arabian, and mediæval European surgery, all chances of the union of operative wounds by the first intention were, as we have already seen (p. 12), systematically set aside by the presence on their surfaces of the inevitable sloughs which were produced by the caustics and cauteries employed to stem the attendant hæmorrhage. The non-union of recent wounds was if possible still more assured by the stimulant and irritating salves and balsams that were busily heaped upon all their raw surfaces whether they had been previously cauterized for hæmorrhage or not. But hot irons were even sometimes applied to portions of wounds which were not bleeding. Thus, Ambrose Paré himself recommends, in the first dressing of amputation-wounds, that the actual cautery be applied to the ends of the bones, because—he argues—they have been "tainted" by "the saw and the appulse of the aire."[1] In Paré's time, and for long afterwards, all gunshot wounds were especially reckoned as tainted or poisoned "by reason of the gunpouder." John de Vigo, who particularly insisted on this doctrine with regard to the "venenate" nature of gunshot wounds, recommended all such wounds to be burned or cauterized with "oyle of elders boyling hot" ("*ferventi oleo sambucino*").[2] War is full of horrors, but surely in these ancient days its horrors must have been intensified by the very idea that those that were struck with shot or bullet were to have their wounds dressed with boiling oil. Paré ingenuously relates how, by a happy chance, his eyes were opened to the gross and cruel character of this established treatment; and the tale is one full of therapeutical instruction even to us. In the year 1536 he accompanied the French army, under the High Constable Montmorency, to the north of Italy; and at the siege of the castle of Villane there were many wounded on both sides, chiefly with bullets. At their first dressing, these cases were treated by all the surgeons of the army on Vigo's plan, namely, by filling as full as they could the wounds made by gunshot with tents and pledgets dipped in the scalding oil of elders. But "it chanced on a time," says Paré, "that by reason of the multitude that were hurt, I wanted this oyle. Now, because there were some few left to be dressed, I was forced, that I might seeme to want nothing, and that I might not leave them undrest, to apply a digestive made of the yolke of an egge, oyle of roses, and turpentine. I could not sleepe all that night, for I was troubled in minde, and the dressing of the precedent day (which I judged unfit) troubled my thoughts; and I feared that the next day I should finde them dead, or at the point of death, by the poyson of the wound, whom I had not dressed with the scalding oyle. Therefore I rose early in the morning, I visited my patients, and, beyound expectation, I found such as I had dressed with a digestive (or ointment) onely free from vehemencie of paine, to have had good rest, and that their wounds were not inflamed nor tumifyed; but, on the contrary, the others that were burnt with the scalding oyle were feaverish, tormented with much paine, and the parts about their wounds were swolne. When I had many times tryed this in divers others, I thought thus much," adds Paré, "that neither I nor any other should ever cauterize any wounded with gunshot."[1] How strikingly and

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[1] *Ambrose Paré.*—See his "Workes," English edit. p. 462. One scarcely wonders, after such treatment, when Paré adds, in reference to the burned and scaling ends of the bones, "You shall thinke you and the patient have exceedingly well performed your parts if they fall away at the thirtyeth day after the amputation."

[2] *Vigo.*—"Opera in Chirurgiâ," lib. iii., tract. 2, cap. 3.; and English translation, p. 182.

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[1] *Paré.*—See his "Workes," p. 409.

Case of Gunshot Wound in a Scottish Nobleman mentioned by Paré.—In the same chapter in which Ambrose Paré details these remarks upon the non-necessity of treating gunshot wounds with "scalding and caustické oyle," he tells his readers, eloquently does this simple story prove to us that some of the orthodox practices in ancient times—

"I having followed many warres, and been deteined as Chirurgion in beseiged citties, as Mets and Hesdin, had observed many things under five kings, whom I served with diligence and content." He adds, that he had "found very many wounds made in the fleshy parts by gunshot, as easily cured as other wounds, which bee made by contusing things;" and in illustration he adduces the case of a Scottish patient of his, that perhaps a Scottish writer may be excused for citing. "For proofe whereof," says he, "I will set downe, that which I not long agone observed in a Scottish nobleman, the Earle of Gordon, Lord of Achindon, whom I cured at the appointment of the Queene Mother. He was shot through both his thighes with a pistoll, the bone being not hurt nor touched; and yet the 32 day after the wound he was perfectly healed, so that hee had neither feaver nor any other symptome which came upon the wound. Whereof there are worthy witnesses, the Archbishop of Glasco, the Scottish embassadour, Francis Brigart and John Altine, Doctors of Physicke, as also James Guilemeau the King's chirurgion, and Giles Buzet, a Scottish chirurgion, who all of them wondred that this gentleman was so soone healed, no acride medicine being applyed."—(Pp. 410, 411). There were, let me add, several surgeons of the name of Bisset or Brisset, connected with Edinburgh in the sixteenth century. One of them was professional attendant upon the queen of James V., and in the royal disbursements we find paid, in April 1542, "to Anthone Brissett, surrurgeane, for laubouris done be him to ye Quenis grace, xx. lib." (see Pitcairn's "Criminal Trials in Scotland," vol. i. p. *325). The case in which Paré cites Giles Bisset as a professional witness could not have occurred till thirty or more years subsequently, as Adam Gordon and perhaps also, let me add, some in our time—may have the double character of being both unnatural and cruel; and yet how difficult has it proved in all ages to change readily any surgical practice that had once become established.

In the ancient primary dressing of wounds, after they were duly cauterized, stimulating and detersive applications were for the most part immediately applied to them, to promote and hasten their sloughing and "mundification." These applications consisted of all possible forms of powders, ointments, liniments, waters, etc., made out of complex farragoes of all possible kinds of substances. The substances were chiefly mineral and vegetable; but the animal kingdom also yielded its due quota. For instance, Paré himself specially lauds the oil of whelps as a detergent application to recent wounds, particularly to gunshot wounds. "This oyle," says he, "hath a wonderful force to asswage paine, to bring the

of Auchindoun only went to Paris in the year 1573. (See Teulet's "Papiers d'Etat relatifs a l'Histoire de l'Ecosse au XVI^e. Siècle," tom. ii. p. 321.)

wound to suppuration, and cause the falling away of the eschar." And, in consequence of his praise and publication of it, "almost all chirurgions," he adds, "have used and daily doe use it with happy successe." He tells us further, that "with much intreaty and expence" he originally obtained the receipt for it from "a certaine chirurgion wondrous famous for curing these wounds." It was made by boiling in four pounds of oil of lilies two new-born "whelpes" (*catellos*) placed alive in the oil, with one pound of earthworms, and afterwards adding three ounces of Venice turpentine and one ounce of *aqua vitæ*.[1] Paré had the honesty and courage to publish the receipt for making this and other topical medicines for wounds; and similar receipts were published by some of the older surgeons. But in the professional works of others, the modes of preparing their wound-waters, ointments, etc., were sedulously and systematically concealed, though their alleged virtues were loudly and pompously lauded.

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[1] *Oil of Whelps.*—See Paré's "Workes," pp. 409, 423, 433; or Latin edit., p. 340, etc.

We have already seen (p. 15), that after cauterization began to be abandoned, and the ligature of arteries to be used, common cut and operative wounds continued still to be elaborately dressed upon their raw surfaces by various mechanical and medicinal applications. Every large wound, at its first dressing, was carefully and artistically stuffed and plugged to its very bottom with tents and pledgets, and stimulating drugs and balsams; and the sides and lips of the wound were thus effectually kept from all chance of adhesion. The surgeon attempted to do everything by the mystery and cunning of his art; and nature was allowed to do nothing. The amount of dressings and applications accumulated upon wounds was something formidable, even in a simple numerical point of view. Thus, less than a century ago, Mr. Bromfeild, one of the most distinguished operators of his day, "Surgeon to her Majesty and to St. George's Hospital," London, in describing the management of a stump, recommends some twelve or more different series of applications to be laid upon it at its primary dressing;

namely, 1st, dry lint on the bone; 2d, a circular piece of old holland to lie within the skin of the stump, or on the cut muscles; 3d, dry lint applied on the outside of this piece of linen to fill up the cavities in the stump; 4th, a little flour on this bit of cloth; or on, 5th, another superimposed layer of lint, which may also be assisted in its compression by applying—6th, a soft bolster of tow on the lint; 7th, small pledgets of digestive ointment spread on lint, and applied to the edges of the stump; 8th, a large general pledget of digestive ointment, or lint; 9th, a compress of tow; 10th, straps of leather and cloth spread with adhesive plaster, and crossed over the end of the stump like the rays of a star at its centre, and kept in their places by passing—11th, a slip of sticking-plaster, spread on leather, round the whole stump, so as to prevent any of the points getting loose; 12th, the usual amputation-cap[1] of Fabricius Hildanus drawn over the stump so as to envelope it, and secured by—13th, a roller wound over it from the end of the stump loosely upwards, with strings sewed to the cap, and fastened round the body.[1]

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[1] *Amputation-cap.*—In his "Commentaries on the Surgery of the War in Portugal, Spain, etc., from 1808 to 1815," Mr. Guthrie laconically and concisely states the era of the disappear-

Two or three great revolutions in the local dressing and primary treatment of wounds have taken place—in English surgery at least—since the days of Bromfeild. *First*, the dressings are no longer applied to the insides and raw interiors of the wound, but now only to their external or cutaneous surface, and after their lips are closed. *Secondly*, the dressings themselves have diminished gradually in numbers and complexity. Many surgical authorities, however, still practise the dressing of stumps, for example, after their edges are stitched together, with a variety of additional applications: as sticking-plasters; a layer of lint spread by some with ointment; pledgets or coverings of loose lint or charpie; and a superincum-

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ance of amputation-caps from English surgical practice as follows: "When the war came well in, stump-caps, as they were called, went out, being worse than useless."—(P. 73 of 5th edit.)

[1] *Bromfeild*—"Chirurgical Observations and Cases," 1773, vol. i. p. 174.

bent roller or bandage. Others advise the wound, after it is stitched or plastered, or both, to have a dressing of wetted lint laid on it with—and perhaps oftener without—a layer of oil-silk, or gutta percha bandaged upon it. But, *thirdly*, another revolution is begun, and will in all probability soon rapidly extend—namely, the practice which I have advocated in the last chapter, of shutting up amputation and other large wounds with appropriate stitches, and then applying "nothing—absolutely nothing." I have for many years past witnessed the good effects of this management in all wounds in obstetric surgery. Two of the most able and enlightened provincial surgeons of England have warmly testified to the superiority of the practice in general surgery, as in amputations. I allude to Mr. Teale of Leeds, and to Dr. Humphry of Cambridge.

In his essay on Amputation, Mr Teale adduces strong evidence of the success which has attended this operation in his hands; and in reference to the dressing of the resulting wound observes, that after its lips are stitched together, "the stump is laid on a pillow over which a large sheet of gutta-percha tissue has been spread. *No dressing whatever* (he adds) is required in the early part of the treatment. A light piece of linen or gauze is thrown loosely over the stump and pillow, and these are protected from the pressure of the bed-clothes by a wire-work guard."[1]

In some observations on the treatment of wounds, published in the British Medical Journal for October 1860, Dr. Humphry remarks, " It is well known, that wounds of the face commonly heal up in their whole length by first intention. This is due, in great measure, to the vital qualities of the parts; and in some degree, also, I apprehend, to the fact that they are usually exposed to the air, their edges being held in contact merely by sutures. For some years we have adopted this plan after amputations, and all, or nearly all, other operations. The integuments are united by sutures placed at intervals of about an inch; and the wound, as well as the adjacent surface, is left quite exposed to the air; no plaster, bandage, or dressing of any kind being placed upon it. The advantages of this mode of treatment are very great. All the irritation, the galling pressure, the retention of heat, and other inconveniences resulting from bandages and plasters, are thus avoided. The edge of the wound and the surrounding skin being uncovered, the eye can take cognisance of what is going on; and we can cut a stitch here and there, when required, can keep the part clean, or take other measures without difficulty. Forasmuch as no dressings are applied there are none to be removed. The suffering which used to be caused by the dressing of wounds after operations is got rid of. In many cases I do not touch the wound, except for the purpose of removing the sutures, from the day of the operation; and several patients, who have undergone amputation under chloroform, have told me, that neither during the operation, nor subsequently, did they experience any pain whatever. We decidedly have more frequent union by first intention than when we were in the habit of applying dressings to the wound."[1]

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[1] *Teale.*—"Amputation by a Long and a Short Rectangular Flap," 1858, p. 9.

One circumstance, more perhaps than all others, has chiefly contributed to the great practical advances which medicine and midwifery have accomplished during the present century. That circumstance consists in the full recognition of the all-sufficient powers of nature in the removal of various formidable diseases and complications that were formerly imagined to be removable only by the efforts of art; whilst, in many others, we acknowledge that art only assists nature, does not replace her,—is her servant and not her master. Practical surgery is undergoing a similar change in many respects, and specially in the treatment of wounds. It is becoming more and more an acknowledged general principle, that the best mode of treating wounds, really and simply consists in placing them in the best conditions for the act of adhesion to go on. "In the dark ages of surgery," to quote the words of Dr. Macartney,

Humphry.—See the "British Medical Journal," Oct. 1860, p. 840.

" nature was allowed to have as little share as possible in the cure, in order that the more might be done by art; and it is to be feared that, even in the present day, surgeons, in other respects well informed, still imagine they effect the union and restoration of parts, in a direct manner, by the means which they employ; whereas all that the best surgery can accomplish, is to place parts in the most favourable circumstances for carrying on reparative operations. If wounds had no natural tendency to heal, of what use would be operations of any kind? What would be gained by placing the ends of a fractured bone in contact? It is nature, not the surgeon, that unites them. Of what advantage would it be to tie an artery, if the parts did not take on themselves the charge of permanently closing the vessel? Surgery, as an art, consists in the performance of mechanic actions; but, as a science, in knowing what is accomplished by nature, and under what circumstances her operations may proceed with the greatest facility."[1]

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[1] *Macartney.*—See his "Treatise on Inflammation," 1838, p. 195.

In glancing backwards into the past history of surgery, it is both startling and humiliating to find how rarely and imperfectly the powers of nature, in the primary union of wounds, are either acknowledged or acted upon. Galen, in one of his best-known works, makes an observation, which is full of interest, in relation apparently to the wounds of the Roman gladiators of his time; for he tells us, that any one might see, in many of those who fought daily in single combat, very large wounds uniting or agglutinated, without any phlegmon, so that by the second or fourth day they were completely healed.[1] In another of his treatises Galen lays down, with much accuracy, two or three of the chief rules for healing wounds, particularly flesh-wounds, by the first intention, and states, that after the lips of divided parts are brought together by sutures or by *fibulæ*, it is nature herself which agglutinates the divided parts and restores them to their pristine unity.[2]

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[1] *Galen.*—"Opera," Kühn's edit., vol. x. (*De Methodo Medendi*), p. 378.

[2] *Galen's treatment of incised wounds of soft parts.*—See his "Opera," Kühn's edit., vol. i. p. 385, or "*Ars Medica*," cap.

During the subsequent, however, and long mediæval era of surgery, the powers of the body in the healing and union of wounds seem to have become less and less trusted to by practitioners of surgery, most of whom came apparently to believe that everything was effected by art. The fact itself, however, that wounds of no small size and depth heal spontaneously and rapidly, was again established and acted upon two or three centuries ago, not by the orthodox surgeons of the time, but by the charlatans and drummer-boys, who were used — often in a concealed manner — to treat the many sword-wounds that were the result of the common and fashionable duelling of these days. They were generally at hand to suck these duelling wounds and stabs, and having

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xxix. In this chapter he recommends the lips of wounds to be *first* brought properly together ; *secondly*, to be kept together ; *thirdly*, all foreign bodies to be carefully removed from their interior ; and *fourthly*, the wounded part itself to be protected by desiccants. These rules of Galen regarding flesh-wounds are repeated in spirit by John de Vigo, " Opera in Chirurgiâ," lib. iii., tract. i., cap. 1 ; Tagaultius, " Institutiones Chirurgicæ," lib. ii., cap. 4 ; Paré, " Workes," pp. 325 and 382 ; Fallopius, " Opera Omnia," tomus ii. p. 176 ; etc.

cleared them of blood, and brought their edges together, they plastered them over with chewed paper or other innocuous and unirritating applications.[1] The grave contemporary surgeons spoke of these marvellous and mysterious cures as the result possibly of magic, at all events of "secret dressing;" for the idea of a deep or extensive wound healing without some kind of artificial dressing, was to their minds a surgical impossibility. They believed in no cures that were not effected by the direct power and interference of surgery. Some quacks appeared, at different times, curing wounds by primary adhesion, through the application to them of linen wetted with water, as has been extensively practised in our own times.[2] But all, or almost all, who granted that water had any such effect, maintained that it must be "charmed" or "blessed" water, endowed

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[1] *Suction of duelling and other wounds.*—See on this subject Lamotte's "Traité complet de Chirurgie," p. 22, etc.; John Bell's "Principles of Surgery," first edit., vol. i. p. 32; etc. etc.

[2] *Water-dressing of wounds.*—In modern times many surgeons, both in Europe and in America, adopted the plan of applying to all recent wounds, after they were closed, layers or compresses of linen or lint wetted with cold water; some renewing this application of water at short intervals; others keeping up its application by a continuous system of irrigation; and others again maintaining

the state of moisture by incasing the wound, in its wetted state, in an impermeable covering of oil-silk. In this last and common mode the water-dressing becomes almost at once changed into a kind of fomentation or poultice; and even in the two first modes the water applied is necessarily not of a lower temperature than the surrounding air, provided that air is allowed, in consequence of the wound being left uncovered, free access to the wound and its vicinity. The only advantage of water over air as an application to wounds is, that it is a better conductor and consequently a better abstractor of caloric. But any wound may be irrigated with air as well as with water. In Germany, the practice of applying compresses, wet with cold water, to wounds, has been greatly lauded by Kern, Klein, Walther, and others. The attention of British surgeons was especially called to the subject by the late Dr. Macartney of Dublin. In his "Treatise on Inflammation," in addition to the evidence of some charlatans, he quotes Fallopius as strongly recommending, in the year 1560, the use of natural water as a fruitful source of success in wounds; Palazzo, as having published in 1570 a book on the true method of curing wounds by simple water applied with hemp or flax (*aqua simplici et frustulis de cannabe vel lino*); and Lamorier in 1732, as asserting that there were few wounds that could not be healed by the use of common water. He adduces also the testimony of Caldani of Padua, and Danter of Gottingen, in favour of the practice. According to him Barons Percy and Larrey also used it. He cites these and other authorities for the purpose of showing that the late Professor Kern of Vienna was wrong in having claimed the credit of inventing water-dressing, though he distinguished himself by being the strenuous through magic with medicinal powers.[1] Incantations and sorcery were believed in as healing agents, but nature was not believed in. Then came one strange episode in this history, during which nature was entirely and successfully entrusted with the cure of some wounds, and yet art was strangely busy, and claimed the credit of it. I allude to the so-called sympathetic cure of wounds,[2]

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advocate for the employment of it in wounds and ulcers, and in the other treatment of surgical operations.—See Dr. Macartney's "Treatise on Inflammation," pp. 185-187.

[1] *Charmed water.*—I have elsewhere given some account of the former use of charmed water in our own country, as a supposed medicinal and surgical agent (see the "Proceedings of the Society of Antiquaries of Scotland," vol. iv. p. 211). Lately a patient from the Highlands informed me, that one of the gamekeepers upon their estate, after having had his inflamed eyes vainly treated on orthodox surgical principles for a considerable time, at last got well whilst using, as a local application to them, water given to him by the "wise woman" of the district. When interrogated as to whether it was simple water alone, he—like one of the old learned surgeons—stoutly maintained that it was not; and when further questioned, what there was in it, he answered, "there were *words* in it." A charm had been uttered over it, and the "words" dissolved in the water were, in the Highlander's estimation, the cause of his cure—and not the water itself.

[2] *Sympathetic cure of wounds.*—See, for example, Papin "De Pulvere Sympathetico," Paris, 1644; Sir Kenelm Digby's "Dis-

when the wounds were closed and left untouched, and the powders, ointments, etc., commonly used in the treatment of the wounds, were vicariously and industriously applied to the weapons that made the wounds, in the form of the *unguentum armarium*,[1] etc., or to the towels and clothes stained with the blood that had flowed from them.

Notwithstanding the rare and shadowy glimpses of the truth seen and taught by a few occasional surgical authorities, it was only very slowly and very reluctantly that the general profession allowed itself to credit and trust the reparative powers of nature alone in the closure of large wounds. They had no real faith in the healing qualities of the coagulable lymph, fibrine, or "balsam" (as it was sometimes termed), which nature formed on recently wounded surfaces. Thus we have already seen O'Halloran, only some one hundred years

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course touching the Cure of Wounds by the Powder of Sympathy," London, 1660 ; etc. etc.

[1] *Unguentum armarium.*—Various essays were published upon this ointment by Robert (1618), Servius (1642), Bartholin (1662), Becker (1664), etc. See Portal's "Histoire de l'Anatomie et de la Chirurgie," tom. vi., partie ii., p. 815, etc.

ago, denouncing as impossible the union of a wound of an inch in length within three days (see *ante*, p. 15). But during the intervening century a wonderful change has swept over the mind of the profession on this question. The reparative powers of nature in the closure of wounds have become more and more acknowledged, and her own healing action more implicity relied upon in practice. All the olden forms of meddlesome interference with her in her work have become comparatively abandoned and denounced in the primary treatment of wounds. Surgeons have, in short, in a great measure transferred their professional allegiance from the surgery of art to the surgery of nature. And truly, as was long ago observed by that wayward professional genius, Paracelsus, nature is the real physician of wounds. " It is," writes he, " the nature of the body — flesh, bones, and nervous parts — to contain within itself an original and innate balsam, which is endowed with the faculty of curing wounds and punctures, and every breach of continuity. It is the natural balsam which conglutinates fractured bones; it is the natural balsam, concealed in the flesh, which heals the flesh-wound. And so every part of the human body contains within it the power of healing; that is, it possesses within itself its natural physician, who repairs the breaches of continuity. Wherefore, let the chirurgeon remember that it is not he that cures wounds, but the balsam which exists in the body. It is then no light mistake if the physician ascribe the cure to himself. For the sole duty of the chirurgeon, and the sole business of chirurgery, is to aid the natural cure of the injured part, by preventing the wound from being irritated by external agencies, and by preventing the curative power of the balsam from being interfered with, that so, with the help of the physician, it may perform its functions unhindered. To speak correctly, therefore," adds Paracelsus, "he who is the good guardian of the balsam is the good chirurgeon (*bonus balsami custos bonus chyrurgus*)."[1]

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[1] *Paracelsus.*—See his "Chirurgia Magna," 1536, tract i. cap. 2.

CHAPTER X.

IS NOT THE ACUPRESSURE MORE DIFFICULT THAN THE DELIGATION OF ARTERIES?

EVERY new practice in the hands of the surgeon is more or less difficult merely because it is new, and because he is not yet familiarised in the employment of it. As compared with the common and established use of cauteries and caustics, the practical difficulties connected with the deligation of arteries, according to the modes in which it was first proposed by Paré, formed in themselves early and strong obstacles to its introduction. Indeed, numerous olden practitioners and authors, as Fallopius,[1] Woodall,[2] Salmon,[1] Nuck,[2] and others,[3] advert to the difficulties connected with the application of the ligature as not only great in themselves, but as almost prohibitory of the adoption and employment of the practice. But, in the course of time, the process of deligation has been much improved and simplified; and the same will probably hold true of acupressure. Other and simpler means of

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[1] *Fallopius.*—" Actio hæc, inquam, difficilis est, neque ab omnibus opportunè fit, quoniam hanc nisi optimi anatomici perficere non possunt." — (Opera Omnia, tom. ii., tract. vii., cap. 10.)

[2] *Woodall.*—" There is great care to be had to the great veine

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and artery—namely, that thou take them up and pierce them thorow, and make strong ligature about them, which must be speedily done, if thou canst do it; but at first I feare thou wilt misse."—(The Surgeon's Mate, p. 159.)

[1] *Salmon.*—" Ambrose Parey, lib. ii. cap. 20, used this way after mputation; but it is very troublesom, and not mightily approved of now."—(Ars Chirurgica. By William Salmon, M.D., living at the Great House by Black-Friers-Stairs, London, p. 771.)

[2] *Nuck.*—" Cùm hic modus admodum sit molestus et patienti dolorificus, illum omnino improbamus."—(Operationes et Experimenta Chirurgica Antonii Nuck, Med. Doct., in Academiâ Lugduno-Batavâ Medicinæ Anatomicæ Professoris, necnon Collegii Chirurgici Præsidis, edit. nov., p. 163.)

[3] *Other objectors to the ligature on the ground of its difficulty.*—See Serjeant-Chirurgeon Wiseman's " Chirurgical Treatises," p. 453; Read's " Treatise of the First Part of Chirurgerie," p. 12; Mihles' " Elements of Surgery," p. 175. See also some remarks on this subject in Dr. Thomson's " Lectures on Inflammation," p. 272.

applying the needle than any which I have proposed will very probably be suggested by others, and consequently the process be rendered even still simpler and safer than it is at present.

In its present condition, however, most of the surgeons who have tried it have found it as easy, at least, as the ligature. After using acupressure in two cases of amputation of the forearm, Dr. Greig of Dundee wrote me that he found the needles "applied quite as easily as the ligature." "The process (says he), so far as I have tried it, is *the simplest* that one can imagine. . . . . It is really surprising how very little pressure is required to stop bleeding from an artery. . . . In giving directions for securing the vessel, you advise the surgeon to place the forefinger over its bleeding mouth, etc. Now, you will find it much better, when you have a flap, to keep the forefinger of the left hand on the skin side, and use the thumb. You feel the vessel beating between the thumb and the forefinger, and you *can introduce the needle in the dark.*"

In the first case of amputation in which Dr.

Handyside used acupressure, he had to undertake the operation at a distance in the country, and improvised some long "darning" needles into acupressure implements for the occasion. He fixed knobs of black sealing-wax upon the heads of them to facilitate their introduction. At that time the two easier modes of effecting acupressure by common short sewing needles had not yet been thought of. But, in order to show that Dr. Handyside found no difficulties in the application of acupressure even with the long needles, let me state in a few words his case—which was, in other respects, a very interesting one—and then quote the comments which he has himself published on it in reference to the question of the relative facility or difficulty of acupressure and deligation.

CASE VIII.—*Amputation of the Upper Third of the Thigh for Traumatic Spreading Gangrene.*—The patient received a very severe lacerated wound of the leg, with compound fracture of both bones, from a loaded waggon running against him down a steep incline. Gangrene supervened, and in five days afterwards, when Dr. Handyside was summoned from town by Dr. Todd of Dysart to see him, he found the patient delirious and prostrated; the mortification had reached the knee, and was spreading upwards; the inguinal glands were much enlarged, and the lymphatics of the limb tense; the pulse rapid, weak, and irregular; and the skin cold and clammy. Dr. Handyside performed amputation of the thigh immediately below the trochanters, and arrested the bleeding from four divided vessels by as many needles. Two of the vessels were relieved from acupressure at the twenty-fourth hour, and the other two—one of them being the femoral artery at its giving off of the profunda branch—at the forty-ninth hour. The swollen lymphatic glands suppurated,[1] it would seem, and after a few days the pus was partly discharged downwards through the centre of the cicatrix, the stump being elsewhere "firm and solid," and partly from two incisions made with the bistoury by Dr. Todd through the recent adhesions. Notwithstanding all the unfavourable circumstances of this case, "the line of cicatrization of the flaps was," to use the words of Dr. Todd, "healed by first intention;" and in twenty-one days the patient was in excellent health, and had a cast of his stump taken in plaster.

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[1] *Formation of pus.*—"Between the fifth and ninth days after the operation," observes Dr. Handyside, "purulent collections had formed. These, however, seemed due to the previous irritation and swelling in the lymphatics in the upper third of the thigh and the inguinal glands—the deep, probably, as well as the superficial—dependent on the spreading of the gangrene."

The woodcut (Fig. 14) shows the shape of the

Fig. 14.

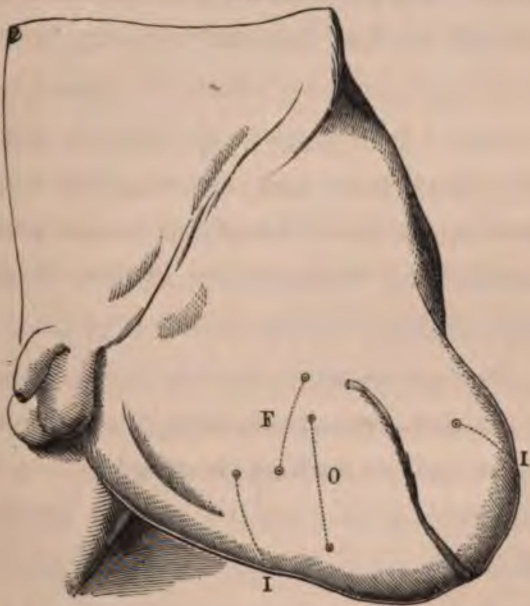

Fig. 14. Stump after Amputation of the Thigh below the Trochanters, showing the directions of the four acupressure needles that were used (Handyside).

resulting stump, and the directions in which the needles passed to secure the four arteries, which were the femoral (*F*), and apparently the obturator (*O*), and two ischiatic branches (*I*, *I*).

This, as I have said, was the first time Dr. Handyside had ever used acupressure, and yet, in his interesting published account of the case, he states :—" The performance of acupressure seems to me to be free from all difficulty." " The hæmorrhage," he adds, " from the divided vessels was arrested with greater expedition in this way than by the ligature ; for, in closing the bleeding orifices by needles, I wholly dispensed with an assistant ; and, in employing needles, I further effected a saving of blood, as well as of time. We may, hence, reasonably conclude that the shock to this patient's system was thereby very probably lessened, and his recovery promoted."[1]

An accomplished country surgeon, Dr. Turner of Keith, has had an opportunity of using acupressure in two or three amputations. " I consider (he writes me three years ago) acupressure as at once efficient, *easy of application*, and conservative; and I will never again employ the ligature where this method can be adopted." "In addition (Dr. Turner more lately writes me) to its chief recommendation, your method has other and not unimportant advantages over the ligature—it is most easy of application, and admits of being quickly applied. It thereby saves blood to the patient, and to the operator—especially if his light be bad, as it often is with us Gideon Grays—pokings with the hot sponge, slackenings and tightenings of the tourniquet, and even exploratory cuttings with the scalpel for the source of the river, to say nothing of the loss of temper liable to occur in the course of the search with the assistant, with or without cause. I have always applied the needle in the way you first proposed, introducing it from without, passing it over the artery, and bringing it out on the other side. I was acquainted with your later mode of adjusting it before my last operation, but I had only the long needles at hand, and, to say the truth, I have found this method *so simple and efficient,* that I should hesitate to adopt the other instead."

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[1] *Dr. Handyside's case of amputation of the thigh for gangrene.*—See the " Edinburgh Medical Journal," December 1860, p. 504, and his reprint of the case with a note from Dr. Todd appended.

Speaking of the two later methods of applying acupressure by short needles,[1] Mr. Edwards has observed,—"Soon after this, Professor Simpson substituted sewing needles for the long pins, threading them with wire, and applying them on the raw surface of the wound. He thus arrested the bleeding in a case where I removed a man's arm above its middle third, and after a similar operation on an infant. The adult stump healed by first intention entirely; the other almost entirely. Since, Dr. Simpson has again further modified the method of application by adding a wire-loop to the needle; the latter can be adjusted with *very great ease and rapidity.*"[2]

Dr. Handyside, though finding no special difficulty with the first mode of acupressure, has published his opinion in favour of the short over the long needles. "Experience," he writes, "now enables me to express a decided preference for *short* over *long* needles. By the use of the former I have found it as easy as by the use of the latter to command the flow of blood from the large as well as from the smaller arteries. Transfixion of the skin is thus avoided—a material point in dealing with a texture weak in its action, and farther weakened by contact with the knife. The accidental entanglement in my bands, unperceived, of two of the wire threads in the foregoing case, shows, however, that some care in manipulation is necessary."[1]

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[1] *Short needles.*—See the second and third methods, already described at pp. 57 and 59.

[2] *Edwards.*—See the "Medical Times and Gazette," for February 14, 1863.

In the present chapter I have adduced the opinions and experience of some excellent surgeons who were intimately and thoroughly acquainted with the ligature before they tried acupressure; and their statements will naturally have a value practically far greater than any that I could myself offer on the relative facilities or difficulties of deligation and acupressure.

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[1] *Handyside.*—See the "Edinburgh Medical Journal," February 1862, p. 716.

CHAPTER XI.

SECONDARY HÆMORRHAGE—IS IT MORE LIABLE TO OCCUR WITH ACUPRESSURE OR WITH DELIGATION?

Any one who has been in the habit of witnessing the closure of vessels against hæmorrhage by the ligature is liable to fall, against his better judgment, into the mistake of supposing that some strong force is necessary to secure arteries against the mischances of primary and secondary bleeding. The mistake originates in the fact that, in seeing the ligature applied, he sees much force employed —so much as will sometimes break a strong thread. But the force here used is, of course, not the force required to stop successfully the flow of blood along the artery, but the force required to divide and tear through the two inner coats of the vessel—

an effect which is necessary to allow of the strangulated external coat being eaten through by ulceration, as speedily as possible. How small, however, and delicate an amount of pressure is necessary to close the mouth of an artery against the escape of blood we know theoretically from physiological experiments upon the force of the current;[1] and we daily ascertain it practically by witnessing, in operations, how very slight a touch of the finger will close temporarily the bleeding mouth of any large artery. In acupressed vessels we find, in the same way, a comparatively small amount of pressure sufficient to occlude their canals, especially if the pressure is applied as directly as possible to the vessel, and without —as I have already advised (pp. 56 and 65)—the intervention of a cushion of elastic tissues between the vessel and the needle. When thus used, the mere simple compression of the needle is—it is now well known—as perfectly effectual in preventing primary hæmorrhage as the mechanical laceration and tightening of the thread. "Intermediary" hæmorrhage, as surgeons term it, or that which—occurring within a few hours after surgical operations—is owing either to all the bleeding orifices not having been occluded at the time, or to some of them being imperfectly secured, is of course as liable to take place with a ligature as with the needles. For in the one case as in the other the intermediary bleeding is the result either of accidental oversight of the bleeding orifices, or of insufficient operative skill and care in the closure of them. But the question occurs—Will *secondary* hæmorrhage, or that form of bleeding which occasionally breaks out from two or three days to two or three weeks after surgical operations, be more liable to follow the acupressure or the deligation of arteries?

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[1] *Physiological force of the arterial current.*—The average pressure which exists in the blood-current of the larger arteries of the larger animals, and hence probably of the human subject also, amounts only to a force equal to the raising of five or six inches of mercury, or in other words, to a force equivalent to a weight of about three pounds on the square inch. (See Valentin's "Textbook of Physiology," by Brinton, p. 192; or Vierordt's "Grundriss der Physiologie des Menschen," s. 101.)

In order to be able to answer this important question correctly, let us for a moment consider what are the common causes of secondary hæmorrhage when the ligature is employed. There are some general or *constitutional* pathological states liable to give rise to secondary hæmorrhage, as the scorbutic diathesis, morbid conditions of the blood in which there is deficiency of fibrin or plasma, etc. These constitutional morbid conditions are all perhaps equally liable to produce secondary hæmorrhage, whatever plan may be primarily employed to arrest it. But far more frequently secondary hæmorrhage depends upon *local* pathological causes. The common local causes of secondary hæmorrhage in deligation are (1.) ulceration and (2.) sloughing of the arterial walls—either so rapid in point of time or so great in point of extent that the cavity of the artery is laid open before its canal has become adequately occluded at and above the site of the ligature. "The most frequent cause," says Dr. Hodgson, "of secondary hæmorrhage, is the ulceration or sloughing of the extremity of the artery."[1]

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[1] *Hodgson.*—See his "Treatise on the Diseases of Arteries and Veins," p. 211.

Secondary hæmorrhage has, says Sir Charles Bell, "two causes—1. The ulceration of the coats where the ligature presses; and, 2. the sloughing of the artery."[1] Speaking of the effects of the ligature, M. Manec states—"If its pressure is too great, and especially upon an artery insulated in a greater space than is required for the ligature, it [the artery] mortifies, ulcerates, and opens before the sides of it have adhered to each other."[2] Secondary hæmorrhage "may occur (observes Dr. Druitt) from sloughing or from ulceration of an artery; or from imperfect closure of an artery when a ligature separates."[3] Or, according to Mr. Syme, "if a ligature has been applied, the ulceration by which it is separated, if too rapid or extensive, may cause a bleeding from three days to as many weeks after the infliction of the injury."[4] These, then, and other surgical pathologists, as Fergusson,[1] Miller,[2] Paget,[3] Wise,[4] and others,[5] all more or less explicitly and correctly state that the common local pathological causes of secondary hæmorrhage are ulceration and sloughing.

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[1] *Charles Bell.*—"Institutes of Surgery," vol. i., p. 61.

[2] *Manec.*—See his "Treatise upon the Ligature of Arteries," English translation, p. 132.

[3] *Druitt.*—"The Surgeon's Vade Mecum," eighth edition, p. 305.

[4] *Syme.*—"Principles of Surgery, 1863," p. 100.

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[1] *Fergusson.*—"It [hæmorrhage] may occur as the result of succeeding sloughing or ulceration when it is said to be secondary."—(System of Practical Surgery, 4th edit., p. 26.)

[2] *Miller.*—"This [secondary hæmorrhage] may be variously induced.—1. By sloughing of the arterial tissue. . . 2. By ulceration at the time of the ligature's separation. . . 3. Or . . ulceration is effected in the arterial coats from without."—(System of Surgery, p. 412.)

[3] *Paget.*—"A ligature may be accidentally separated too early; or with over-feeding the small vessels of the wound or its granulations may be over-filled, and give way with considerable bleeding; or bleeding may occur through scurvy or the hæmorrhagic diathesis; but with these exceptions the secondary hæmorrhages from wounds may be always referred to sloughing or ulceration of the walls of arteries, or, much more rarely, of veins."—(Holmes' System of Surgery, vol. i., p. 604.)

[4] *Wise.*—"In some cases, from some peculiarity of constitution, from the size and number of the ligatures, the mode of dressing, etc., a higher degree and greater extent of inflammation occurs in the artery than is required for the adhesive process; and a softening ulceration occurring is followed by secondary hæmorrhage."—(Essay on the Pathology of the Blood and its containing vessels, p. 316.)

[5] *Others.*—See, for instance, John Bell's "Principles of Surgery," vol. i., p. 225; Travers' observations upon the ligature of arteries, in the London "Medico-Chirurgical Transactions," vol. iv. (1813), p. 450; etc. etc.

But in *every* case of deligation there is inevitably, as we have already seen (see Chapter IV.), more or less ulceration and sloughing as an unavoidable consequence of the use of the ligature. It is when one or other, or both, of these processes proceed to a morbid excess and depth, that secondary hæmorrhage from the opened arterial tube follows. In acupressure, on the other hand, there is no ulceration or sloughing whatsoever of the arterial tube; its cavity becomes obliterated after merely laying its internal surfaces in contact by the pressure of the needle. And hence, secondary hæmorrhage as the result of its two common causes—viz., ulceration and sloughing—should be almost or altogether unknown when acupressure is resorted to.

In the present limited state, however, of our knowledge regarding the mode or mechanism of the occlusion of arteries by acupressure, and the time required for it, acupressure has been followed by secondary hæmorrhage in two amputations out of the pretty long list in which the vessels in stumps have been acupressed. These cases and their causes are, therefore, considerations of no small moment. In the first of the two, probably the needle was withdrawn too early, and before the sealing up of the arterial tube was fully accomplished. In the second case, the process of internal closure of the tube by an internal plug and cohesion was probably delayed much beyond the usual time by the state of impaired health and impaired blood of the patient; or, in other words, by constitutional causes. The first has been reported by Dr. Hamilton in his Carlisle list of cases:

CASE IX.—*Amputation of the Thigh, with Acupressure and Secondary Hæmorrhage.*—A boy, aged five and a-half years, underwent primary amputation of the thigh, at its lower third, for a railway accident, which had mangled the leg. Twenty-four hours after the amputation, Mr. Page withdrew the only two acupressure needles that had been required, when bleeding immediately occurred to the extent of two ounces. The dressings were at once removed, and the stump raised, when the hæmorrhage ceased. There was no tension or redness of the flaps. The blood escaped by the opening left by the wires of the acupressure needles. Except at this point, there was union by the first intention along the whole line of incision. For the next two days, the pulse, as on the first day, was high, with vomiting and much tossing. After a fit of restlessness, hæmorrhage recurred from the wound forty-one hours after the withdrawal of the needles. It ceased under manual compression of the femoral and raising of the stump. "Having," says Dr. Hamilton, "adjusted a tourniquet over the vessel high up, I forcibly tore asunder the flaps, which were adherent from end to end, except at the small orifice by which the blood escaped on the 26th; then clearing out some newly-formed clots, exposed the bleeding orifice, which proved to be that of the popliteal. I then passed a needle under it, and secured it in the usual manner. The hæmorrhage being completely checked, the flaps were approximated by four points of wire suture. On this occasion it was calculated that between four and five ounces of blood were lost." There was no recurrence of hæmorrhage. Sixty-nine hours after the introduction of the needle it was withdrawn; and within five weeks after the amputation, the wound from it was quite closed and healed.

Perhaps, in this instance, the needles were withdrawn too early—that is, within twenty-four hours after amputation of the thigh. More evidence, however, as I have already argued, and more experience, are required on this point before any very fixed principles can be laid down. Betimes I shall have occasion to speak of a case of thigh-amputation, where the needles were withdrawn in a young child within twenty-four hours, and without bleeding following. In conversation upon the preceding case, Dr. Hamilton informed me that he was inclined greatly to attribute the second attack of hæmorrhage to the little patient's ungovernable restlessness.

In Dr. Hamilton's report of amputations at the Carlisle Hospital, there are given eleven cases where the ligature was used, and eleven where acupressure was employed. Among the latter eleven there was only the preceding case of secondary hæmorrhage. Among the former eleven, where the ligature was used, there were four cases of secondary hæmorrhage, and two of these were cases of fatal secondary hæmorrhage. In other words, there happened in that institution four times more cases of secondary hæmorrhage from the ligature than from acupressure.

CASE X.—*Amputation of the Thigh—Secondary Hæmorrhage after Acupressure.*—In the case of a phthisical young man, of twenty years of age, Mr. Crompton, the able Surgeon to the Birmingham Hospital, performed circular amputation in the lower third of the thigh, on account of severe compound comminuted fracture of both tibia and fibula—the result of an engine-tender having passed over his leg. The femoral artery was secured by an acupressure needle, and two small muscular arteries were twisted. After seventy hours the stump was in great measure united, but there was still pulsation over the needle near its point of exit. Mr. Crompton, therefore, hesitated about withdrawing the needle, but, as there was considerable inflammation and suppuration in its track, he ventured to remove it. No hæmorrhage took place at the time, but two days afterwards Mr. Crompton found four or five ounces of coagulated arterial blood on the bed, and more blood still oozing from the depending part of the incision. He at once reintroduced the acupressure needle a little higher up, and thus arrested the bleeding completely. The hæmorrhage was attributed to the patient having made use of the bed-pan about half-an-hour before. That same day slight symptoms of phlebitis had been noticed. Shivering and vomiting soon followed, and the patient became delirious at times, and died of pyæmia on the tenth day after the operation. On examining the body, "the external iliac," Mr. Crompton writes to me, "and the common and superficial femoral arteries on the right side, were found quite empty, even down to the position of the needle, and the lining coat was of its natural colour, except at the point of pressure, where there was a line of blue discoloration. The external iliac and common and superficial femoral veins were filled with decomposed clots and sero-purulent fluid. This state did not extend into the common iliac vein or the vena cava." The apex of the left lung was "adherent," says Mr. Crompton, "containing several small cavities. Around them, for two or three inches, the tissue of the lung was filled with tubercular matter."

In this patient, it would appear that the internal consolidation and organisation of blood or fibrine necessary for the permanent occlusion of the injured artery had never properly taken place. Whether this deficient action was owing to the previous low state of the young man's health, as testified by the tubercular disease in his lungs, or to the depression resulting from the injury and the operation, or to some other cause, it is not, perhaps, possible to determine. It possibly would have occurred equally with the ligature. But an important lesson in acupressure practice is, I think, read to us by this interesting case; for, according to the very sagacious observation of Mr. Crompton, the pulsation could be felt going on along the artery down to the very point of compression by the needle; and the lesson, I take it, is this—that *in any doubtful case, so long as the arterial pulsation may be felt or seen close to the needle*—as can often be done immediately after its insertion—we may regard it as an indication that perfect consolidation and permanent occlusion have not yet taken place, and that the time for the withdrawal of the needle has not yet arrived.

CHAPTER XII.

GENERAL OBJECTIONS AGAINST ACUPRESSURE.

No improvement in our profession has ever, perhaps, succeeded without, in the first instance, being more or less strongly and strenuously opposed. In consonance with this common and healthy law, there has been adduced, since I first suggested it, a variety of arguments against acupressure, both of a general and of a special kind.

Some of the earliest general objections urged consisted, of course, of the two old standard objections, which are always ready to be adduced against every proposed innovation in practice, namely—*First,* that the proposed practice is not new; and, *Secondly,* that it is not true, or, in other words, will not be found to have the power claimed for it—that power being in this instance the power of arresting hæmorrhage.

In relation to the *first* of these objections, I think it right to remark, that before bringing at all the subject of acupressure under the notice of the Royal Society of Edinburgh in December 1859, I took occasion to look over a great number of chirurgical treatises, both ancient and modern, with the full expectation of finding some notice of such a practice in the past records and suggestions of surgical science. Nowhere, however, did I meet with any hint as to the *needle alone* being ever employed as a hæmostatic compressing agent.

During 1829–30, M. Velpeau, in some experiments upon dogs, with a view to the cure of aneurism, tried to obliterate the course of the femoral and other arteries, by transfixing or piercing the cavity of the vessel, and leaving the portion of needle which traversed the arterial tube as a foreign body, around which a coagulum might form.[1] In 1831, and seemingly quite independently of M. Velpeau, Mr. Benjamin Phillips of London performed a series of similar experiments upon the obliteration of the tubes of arteries in dogs, etc., by passing a common needle through the cavities of these tubes. When sufficient time was allowed to elapse, he found that the needle, as a foreign body in the arterial tube, generally occasioned the formation of a clot or coagulum around it, so as to occlude the artery,[1] a result already attained, in

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[1] *Velpeau.*—Médecine Opératoire, tom. i. p. 128.

Fig. 15.

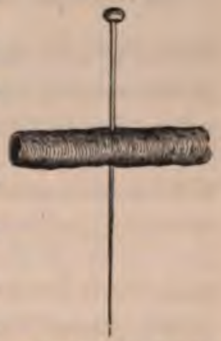

Fig. 15.—Diagram of acupuncture of vessels. After Bourjery.

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[1] *Benjamin Phillips on the acupuncture of arteries.*—See his essay, entitled "A Series of Experiments performed for the purpose of showing that Arteries may be obliterated without Ligature, Compression, or the Knife," London, 1832. Mr. Phillips states that he performed his experiments with the hope of discovering some mode of arresting the progress and effecting the cure of aneurisms, *without* resorting to the use of the ligature of the arterial tube involved—having long entertained the conviction that if he could "devise any mode by which inflammation might be excited in the parietes of an artery, that inflammation would be followed by coagulation and a consequent obliteration of the artery" (p. 19). To add to the sufficiency of the coagulating and irritating effect of the needle in the arterial tube, Mr.

1826, by Sir Everard Home inside an aneurismal sac by introducing a heated needle into its cavity.[1]

Phillips, in an appendix to his essay, suggested the application of galvanism to the needles, conceiving that by concentrating the galvanic fluid thus upon a given point of a vessel he could excite there coagulation and obliterative inflammation. In 1856, Ciniselli collected together fifty cases of aneurism, which had—up to that date—been treated by galvano-puncture, as originally suggested by Mr. Phillips and M. Guerard. Twenty-three of the patients were cured, twenty not cured, and in seven death had resulted.—(See Ciniselli's essay "Sulla Elletropuntura nella Cura degli Aneurismi;" and Holmes' "System of Surgery," vol. iii. p. 432.) The same principle of galvano-puncture has been used in Italy by Capelletti, Bertani, and Milani, to produce coagulation of the blood in the veins in cases of varix.—(See the "Archives Générales de Médecine" for 1848, tom. xviii. p. 228; and Malgaigne's "Médecine Opératoire," 1853, p. 160.)

[1] *Everard Home's case of solidification of the contents of a large aneurism by the heated needle.*—This interesting case seems to have almost entirely fallen out of notice in surgical literature. In an aneurism of the external iliac artery, Sir E. Home tied the femoral artery below the sac; but finding this operation useless, and the tumour growing, he "was led (twenty-eight days afterwards) to introduce a needle, to which is given the name of acu-punctorium, into the centre of the tumour, where the pulsation was most violent, and the fluid state of the blood most distinctly felt: the needle was passed through a small orifice in a bar of steel three inches long, the skin of the thigh was guarded by cork, and the needle was heated through the

It is scarcely necessary to observe that these experiments and suggestions of Velpeau, Phillips, and others[1] with transfixing needles, were founded

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medium of the steel by a spirit lamp." After this was continued for fifteen minutes, the pulsation in the tumour was diminished; and in half an hour, after some pain, the throbbing in the sac was reduced to an undulation. After six days, and again after ten more days, the needle was a second and third time used with the heated plate in the same manner. On the third trial after the needle "had been immersed twenty minutes, the pulsation all at once stopped," and never returned, and the aneurismal tumour "to the feel appeared solid." Six days subsequently, the limb became cold, and gradually more distinct symptoms of mortification in it began to appear; but had not increased much when the patient died, thirty-six days after the last employment of the needle. On dissection, the contents of the aneurism were found solidified. "The upper portion of the sac occupied a part of the cavity of the pelvis, and by its pressure prevented the branches of the internal iliac artery from supplying the thigh with blood."—(See drawings of the aneurism and its solidified contents, and of the foliated structure of the blood coagulated by the heated needle, in Plates III. and IV. of the "Philosophical Transactions of the Royal Society of London" for 1826, p. 189, *sqq.*)

[1] *Acupuncture of vessels by others.*—M. Velpeau states, that M. Nivert and M. Amussat had repeated his experiments upon acupuncture of arteries, but Amussat did not obtain results so conclusive as his own.—(See his Médecine Opératoire, tom. i. p. 128.) Sir Robert Carswell informed Mr. Phillips, that he assisted M. Amussat, and that the experiments "had been deemed inconclusive."—(See Phillips' Essay, p. 53.)

on entirely a different principle from needle-compression. They were instances of the acupuncture of vessels, and not of the acupressure of them.

The plan of using a *needle and wire*, or needle and thread, in conjunction together, as in the third method of acupressure which I have already described (p. 59), has been long used to some extent as an indirect hæmostatic means—not so much to individual bleeding vessels as to surfaces of bleeding tissue—in harelips;[1] and occasionally also in other affections where twisted sutures are employed, as in the treatment of varices and of

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[1] *Twisted suture as an indirct hæmostatic means in harelip*, etc.—Thus, to quote a modern authority upon the hæmostatic effects of the needle and thread in arresting the hæmorrhage in the cure of harelip, Professor Chelius observes, that in this operation "the bleeding is generally inconsiderable, and stanched by the *close junction* of the fresh-made edges, which is best effected by the twisted suture."—(See his "System of Surgery," translated by South, vol. i. p. 597.) Many of the older surgeons describe, under the names of the *Sutura Suppressiva* and *Sutura Restrictiva*, the stitching firmly and deeply together the lips of bleeding wounds, so that their mutual compression be used to stay the hæmorrhage; and this was done by various forms of suture besides the twisted—as the continuous, the quilled, etc. See, on this subject, Guy de Chauliac's "Chirurgia," Leyden, 1572, p. 172; Fabricius ab Aquapendente's "Opera Chirurgica," Leyden edit. of 1723, fol. 174; "The Workes of that famous Chirurgian Mr. Iohn Banester," 1633, p. 199; Alexander Read's "Treatise of the First Part of Chirurgerie," 1638, p. 51;

Pedro Lopez de Leon's "Pratica y Teorica de las Apostemas, &c., Question," 1685, p. 161; Richard Wiseman's "Chirurgical Treatises," 1676, p. 353; John Bell's "Principles of Surgery," 1801, vol. i. p. 449, etc. The *sutura restrictiva* "was not intended," says Mr. Bell (p. 49), "for reuniting the wound, but for preventing effusion of blood; they did not sew up the particular vessels to prevent bleeding, but sewed up the *general wound* so close as to confine the blood." On the same principle Lowenhardt suggested, as a means of arresting the hæmorrhage in troublesome leech-bites, particularly in yielding parts, the passing of a stitch though the lips of the aperture, and tying them tightly together with it.—(See Graefe and Walther's "Journal der Chirurgie," etc., vol. xv. p. 119.) Dr. Townsend regards this sewing and compression of the lips of the leech-puncture with one or two firm stitches, as the best method of arresting this form of bleeding.—(See his translation of "Velpeau's Operative Surgery," vol. i. p. 268.) Mr. Yeates Hunter pinched up the bleeding orifice between the nails of the thumb and fore-finger used as forceps, and had a silk ligature applied beyond the nails, tightly around the whole included part.—(See "Lancet" for Aug. 21, 1830, p. 844.) In 1819, in the "London Medical Repository," vol. xi. p. 25, Mr. Anthony White tells us, that for five or six years previously he had always, when necessary, effected successfully the same object by taking a fine sewing needle, passing it through the leech-bite—piercing as much of the skin on each side as was sufficient to obtain a moderately firm hold—and then conveying beneath the needle a few turns of thread, so as to produce complete and effectual pressure on the bleeding orifice.—(See, on the same subject, Cooper's "Dicnævi and other vascular tumours; and Velpeau[1] suggested, but apparently never tried in practice, whether the plan could not be applied to the tubes of arteries supplying aneurisms, as well as to the tubes of varicose veins. But I am not aware of any proposal previous to my own, to use it as a means of arresting the hæmorrhage in common surgical operations; or, in other words, to use it for the closure of the ends or mouths of arteries laid open in surgical wounds.[2]

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tionary of Practical Surgery," 7th edit. p. 699; and Graefe and Walther's "Journal der Chirurgie," vol. i. p. 185.)

[1] *Velpeau.*—See his "Médecine Opératoire," tom. i. p. 87. His only experiments on the subject were, he says, made upon dogs.

[2] *Conjoined needle and thread as a means of closing the ends of arteries laid open in surgical wounds.*—Since the observations in the text were first published in the Medical Times for 16th January 1864, I have met with remarks by one or two different authors which appear to me to deserve to be noted here.

Thus, in his edition of the "Principles of Surgery" of Mr. John Bell, to the story told by his brother of Roonhuysen setting two tailors down to compress with their thumbs the bleeding orifice from an ulcer on the back of the penis, Sir Charles Bell adds the following remark:—"The manner of stopping such a bleeding is to pass a fine sewing needle across the bleeding *pore*, and then to cast a thread over the needle and so draw it, letting the needle remain until next day" (see vol.

The *second* general objection which I alluded to —namely, that the needles would not produce the

i. p. 241). In his own work on the "Institutes of Surgery," he repeats the same observation as applicable to "a small bleeding orifice as from a callous ulcer or from the glans penis in a state of ulceration" (vol. i. p. 60). But though Sir Charles Bell thought this means applicable to a bleeding orifice or pore in a callous or other ulcer, he has nowhere suggested that it is applicable to the mouths of vessels laid open in surgical wounds.

An English provincial surgeon of the last century, Mr. Lambert of Newcastle, made a suggestion regarding the closure of wounds in an artery—such as the brachial from bleeding—that perhaps should be noticed under our present head. Wounds in the tubes of arteries that would lead to aneurisms might, he fancied, be closed—like the union of the divided part in harelip—by a needle and thread *in* their walls used as a suture, and without the artery "becoming impervious." He apparently believed that the walls of the tube of an artery could be stitched together in this way, as the walls of the tube of the intestine have sometimes been proposed to be done—leaving, however, the tube itself patent. He has stated one case in which it was supposed to be effected in an artery wounded at the bend of the arm in bloodletting. The artery was laid bare by dissection, and its wound discovered. "Then," to quote his own words, "a small steel pin, rather more than a quarter of an inch long, was passed through the two lips of the wound in the artery, and secured by twisting a thread round it, as in the harelip. This was found to stop the bleeding." The pin came away on the fourteenth day. But perhaps the credit of the cure was little due to it, and more owing to other agents. For he tells us that two ligatures also, one above the bleeding orifice and one below, were passed under effects theoretically claimed for them, has now been fully set aside by the experience of their employment in many operations—in several amputations of the thigh, and numerous other amputations of the limbs, in excisions of the mamma, and of tumours, etc. That the needles can and do arrest surgical hæmorrhage as certainly as the ligature, is now well known to all who have seen them employed. Acupressure, however, is still in its infancy; and the history of other similar innovations in surgery does not offer strong hopes for any very speedy or general introduction of it into practice. In evidence of this remark, let us proceed, in the next chapter or two, to take a rapid retrospective glance at the slowness and the difficulty with which the hæmostatic means

the artery, that they might be ready to be tied at any time in case the method proposed should fail. These two ligatures "remained loose in the flesh, like two setons," till the fourteenth day, when they were removed.—(See the "Medical Observations and Inquiries by a Society of Physicians in London," 1764, vol. ii. p. 360.) In a second attempted case of this operation, Mr. Lambert and Mr. Leighton failed (see Charles White's "Cases in Surgery," 1770, p. 163); as did also John Bell in a third case.—(See his "Principles of Surgery," vol. i. pp. 204 and 209.)

at present most employed by surgeons—namely, the ligature of arteries—came to displace the old cauteries and caustics that were formerly employed for the arrestment of surgical hæmorrhage. The introduction of the ligature in two such operations, for example, as (1) amputation of the limbs, and (2) excision of the mamma, will enable us to trace the great opposition which the deligation of arteries had to overcome before it was allowed to become an established principle in surgical practice,—and the great length of time which elapsed before this end was obtained. Nor must we forget, in instituting and pursuing this inquiry, that—as has been already stated (p. 2, *sqq.*)—these and other severe operations were long systematically avoided as far as possible, because they were liable to be followed by formidable and sometimes fatal hæmorrhage.

CHAPTER XIII.

RETROSPECT OF THE MODES OF ARRESTING HÆMORRHAGE IN AMPUTATIONS OF THE LIMBS.

IN the amputation of limbs, surgeons have sometimes used means and operated under conditions which prevented hæmorrhage; and they consequently did not require the use of any measures for its suppression. In ancient times, for example, the operation was only undertaken by most practioners, where the limb was quite mortified, and the incisions could be made through dead—and consequently through non-bleeding structures. In later times, limbs have been removed, by the strangulation of ligatures and by linear écrasement, and hæmorrhage thus avoided though the dismemberment passed through living structures. With these, however, and similar bloodless forms of amputation, we have nothing to do in the present inquiry. Nor is it necessary to detail the various modes[1] and machines by which amputations, through living and bleeding tissues, have been effected at different periods in surgery. For, whether effected by common amputation-knives, or by the pincers, or chisel and mallet, pictured by Scultetus,[1] Guillemeau,[2] and Heister;[3] or by the guillotine-like machinery of Pere and Botallus,[4] the result was the same in all—that, where the living tissues of the limb were cut through, a rapidly bleeding surface was inevitably exposed; and the sole question which interests us at present consists in the

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[1] *Amputation by instalments.*—One of the strangest modes of amputation ever proposed is that of M. Faure. Believing the danger of the operation to result from the shock and size of the wound, he seriously suggests to remove the limb by three or four cuts, with an interval of several days between each, leaving the instalment containing the principal vessels for the last section; and he questions whether it would not be right to allow the precedent incision to be well healed before resorting to the next.—(See the article "Amputation" in the "Encyclopédie Méthodique; Médecine," 1790, tom. ii. p. 210.) A dauntless naval friend of mine was once obliged to amputate the limb of one of his crew when he had no surgeon on board his ship. The leg was terribly and hopelessly shattered and fractured, and the poor patient was anxious rather to live with three limbs than die with four. A turn-stick tourniquet was applied and twisted with all the art—and all the prowess too—of the hands of a powerful sailor, so as effectually to prevent the mischances of hæmorrhage; and the incisions were begun. But my friend and his officers had to stop from time to time during the operation and dressings, to read up a little from a surgical work which was laid open beside them, as to what exact step should next be taken. At last the bone was divided, the vessels—and something more—secured in ligatures, which were applied with considerable difficulty, but tied with uncommon vigour; and the wound was duly dressed. The patient made a good recovery; and I have repeatedly heard my friend boast, that the stump which he made turned out as capital a stump as was ever made by a fellow of the College of Surgeons.

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[1] *Scultetus.*—See his "Chyrurgeons Store-House," English edit., pp. 48-50, where the pincers, and chisel and mallet, are described and figured. With the pincers he hacks away fingers and toes, and with the chisel and mallet he chops off "not only the tops of the fingers, but also of the arm and of the radius."

[2] *Guillemeau.*—See his "Chirurgie Françoise," Paris, 1594, p. 15. Diagram of amputation of a finger with large pincers.

[3] *Heister.*—See his "General System of Surgery," 8th English edit., vol. i. p. 353, and Plate XII. Fig. 17, representing the amputation of the great toe with a chisel.

[4] *Amputation of limbs by guillotine-like machines.*—"Monsieur Pere, the French chirurgeon, has invented," observes Purmann, "a machine which, by its great weight and sharpness, cuts at once the skin, flesh, and bones asunder. Others, complying with the method of Botallus, fasten one knife under the member, and the other above, and then, with a sudden fall of a great weight, cut the limb asunder. The first machine I saw used at Wesel, but without success; for it did not cut the leg through at once, but stopt in the bone, and was forced to be repeated, which made many shivers, splinters, and an uneven bone. The second I saw done by Mr. Crause, a chirurgeon at Quedlingberg, on a country man's leg, which, by reason of its great weight went something better than the former; but the knives turned,

the *os tibiale* was cut uneven and not quite through, and therefore he was forced at last to cut it rightly off with the knife and saw. So that, all things considered, the ancient way in cutting through the flesh with a knife and through the bone with a saw is more practicable, safe, and certain than any of the new inventions."—(See Purmann's "Chirurgia Curiosa," English edit., p. 210.) In proposing to sever limbs, by lopping them off by one instantaneous stroke of his amputation-machine, Botallus argued that the operation would be safer and less painful than when done more slowly with knife and saw; and he and others believed also that the rapidity of such amputations tended to save blood, for (he imagined) "illico arteria et vena occluduntur."—(See Botallus' "Opera Omnia," edited by Van Horne, 1660, p. 791.) According to O'Halloran, Botallus took the hint of his machine "from the Scots manner of decollating state criminals."—(See O'Halloran's "Treatise on Gangrene and Amputation"—Introduction, p. xx.) The gaunt and formidable old Scottish machine for the "decollation" of state criminals, referred to by O'Halloran, is still carefully preserved at Edinburgh in the museum of the Society of Scottish Antiquaries. By this identical instrument—the so-called "Maiden"—were beheaded Archibald, Marquis of Argyle, in 1661, and his son Archibald, Earl of Argyle, in 1685; the Regent Morton in 1681; Sir John Gordon of Haddo in 1664; President Spottiswoode in 1646; and many others. The earliest known decapitation by the "Maiden" was in the case of one of the murderers of Rizzio in 1566. See a drawing of the instrument in the 1st edition of Professor Daniel Wilson's "Archæology of Scotland," p. 689.

consideration of the means by which the vessels thus laid open in amputation were closed by the surgeon, and the appalling hæmorrhage issuing from them was artificially stanched and suspended.

Previously to the middle of the sixteenth century, the hæmorrhage in amputation-wounds—when that operation was ventured upon at all—was usually restrained by one method only—namely, by the cauterization of the bleeding surface and orifices, and by red-hot irons and chemical caustics, or more rarely by boiling oils and pitch;[1]

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[1] *Potential caustics; heated oils; Vitriol Buttons.*—In speaking of potential cauteries, Mr. John Bell remarks—"In this rank were many fluids which had no other effect than as they were hot; even melted sulphur was used, and melted lead, and boiling oil, the temperature of which is equal to melted lead; but the boiling oil of turpentine was the favourite application. Kettles of boiling turpentine were kept in readiness in the cockpit during a battle at sea, and in hospitals when great operations were to be performed; but their chief potential cautery was blue vitriol [sulphate of copper], which was applied in the following manner: The vitriol was pounded grossly (not very small), it was wrapped up in a linen rag; this little bundle, like a waistcoat button, was what they called a button of vitriol; and the blood being for a moment suppressed by the tourniquet, this

for the vessels divided were too large to be shut up by compresses, styptics, and absorbents.[1] For many long centuries the rapid deep burning and charring of the bleeding part was the orthodox and established method of arresting hæmorrhage in this operation. Fire, as the chief hæmostatic, was, says Dionis, "so much in use among the ancients, that they employ'd it in almost all their opera-

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vitriol button was placed carefully upon the mouth of the wounded artery. The tourniquet was let go after some interval of time, and very slowly. The exuding of the blood dissolved the vitriol slowly. This caustic affected the artery, made an eschar like that of the actual cautery, which fell off after some days."—("Principles of Surgery," vol. i. p. 151.)

[1] *Styptics and absorbents.*—"Styptics," observes Mr. Syme, "are agents which, independently of any compressing effect, possess a power of checking hæmorrhage. Of these may be mentioned the sulphates of copper, zinc, iron, and alumina, and the nitrate of silver; strong spirits, oil of turpentine, and the actual cautery; also soft spongy or powdery substances, such as dried lycoperdon, spiders' webs, and the agaric of the oak, or amadou. This last constituted the famous styptic of Brossard, which possessed a very high reputation both in France and in this country towards the close of the last century. Before the proper principles for applying the ligature were ascertained and received, styptics were regarded as important means for controlling hæmorrhage; but they are now very little used."—(See Mr. Syme's "Principles of Surgery," p. 99.)

tions. They heated red-hot their actual cauteries, of which some were shap'd like a button, others like an olive, and a third sort like a platin. They apply'd them red-hot to the orifices of the vessels as soon as the member was separated, and by thus burning the vessel and adjoining flesh, they form'd a scar which hindered the issuing out of the blood. But this cruel way was uncertain, because when the scar came to fall the blood flew out with the same violence as on the day of the operation; which has put the Artists of our profession on the search of gentler ways than that of fire."[1]

It is hence, surely, no marvel that the old English surgeon, Thomas Gale, writing on the subject of amputation in 1563, should tell us that the heated irons so "sore feared the people with the [h]orror of cauterization that many of them rather would dye with the member on, then to abide the terrible fire; by meanes whereof many people perished."[2]

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[1] *Dionis.*—See his "Course of Chirurgical Operations;" London, 1733, p. 408.

[2] *Gale.*—"Certaine Workes of Chirurgerie," edit. of 1586, p. 63.

It is difficult for the mind to realise the untold agonies of the surgical sufferers of these times, under the dreadful double ordeal of cutting and burning—of knife and fire. "The horrors of the patient," exclaims John Bell, "and his ungovernable cries, the hurry of the operator and assistants, the sparkling of the irons, and the hissing of the blood against them, must have made terrible scenes; and surgery must, in those days, have been a horrid trade."[1]

A new and a brighter era dawned upon operative surgery, when, in 1564, Ambrose Paré—a man evidently of most original and masterly surgical talents, and of rare professional courage[2]—published the great and happy proposition of substituting the deligation of the bleeding vessels with simple threads instead of their cauterization

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[1] *Bell.*—"Principles of Surgery," vol. i. p. 151.

[2] *Paré's talents and courage.*—In various parts of his works Paré indulges his readers with delectable autobiographical glimpses of his own character. For instance, he was in the Turin campaign in 1536, when he was twenty-seven years old; and in a chapter on this campaign, he naïvely and quaintly gossips to us of his own surgical powers. In talking of his professional consultations with a distinguished Italian physician and other surgeons, he adds, "When wee had resolved to doe any serious worke of Chirurgery, *twas Ambrose Paré that put his hand thereto*, where I did it promptly and with dexterity, and with a great assurance, insomuch that the sayd Physition admired me to see me so

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ready in the operation of chirurgery seeing the *small age* which I had."—(Workes, p. 1143.) Though often serving as an army surgeon, his courage, however, seems to have been much more professional than military. One of the four conditions which he obtained from his royal master Charles IX. was, that he should never be asked to go into the field of battle; and he incidentally confesses (p. 1147) that when serving against the English at Boulogne in 1545, he ducked his head for fear of a cannon-ball, and the soldiers mocked at him for being "affraid of a bullet *already* gone." In speaking of the siege of Hedin in 1553, he gives an instance of his interfering in military matters in a manner anything but creditable to his military memory. When telling of being shut up in the besieged castle, he states:—"There was a quicke cleare fountaine or spring, within cannon shot, where there was about foure-score whores and wenches of the enemies, who were round about it to draw water. I was upon a rampart beholding the campe, and seeing so many idlers about the sayd fountaine, I prayed Monsieur de Pont, commissary of the artillery, to make one cannon shot at that roguish company; he made me much deniall, answearing me that such kind of people were not worth the powder they should waste. Againe I prayed him to levell the cannon, telling of him, the more dead the fewer enemies; which he did through my request, and at that shot fifteene or sixteene were kild and many hurt" (p. 1155). This cruel and useless slaughter of defenceless women can only be justly looked upon as an act of merciless murder, and not as an act of war.

with red-hot irons. He tells us that in the earlier period of his practice, he "used to stanch the bleeding of members after amputation" by cauterization, "whereof I am ashamed," says he, "and agreived. But what should I doe? I had observed my maisters whose method I entended to follow, alwaies to doe the like; who thought themselves singularly well appointed to stanch a flux of blood, when they were furnished with various store of hot irons and causticke medicines, which they would use to the dismembred part, now one, then another, as they themselves thought meete. Which thing cannot be spoken or but thought upon without great horror, much lesse acted. For this kind of remedy could not but bring great and tormenting paine to the patient, seeing such fresh wounds made in the quicke and sound flesh are endewed with exquisite sense. . . Adde hereunto that when the eschar fell away, oft times a new hæmorrhagye ensued, for stanching whereof they were forced to use other causticke and burning instruments. . . . Wherefore, I must earnestly entreate all chirurgions, that leaving this old and too, too cruell way of healing, they would embrace this new, which, I think, was taught mee by the speciall favour of the sacred Deitie; for I learnt it not of my maisters, nor of any other, neither have I at any time found it used by any. Onely I have read in Galen that there was no speedier remedy for stanching of blood, than to bind the vessels through which it flowed towards their rootes—to wit the liver and heart. This precept of Galen, of binding and sowing the veines and arteries in the new wounds, when as I thought it might be drawne to these, which are made by the amputation of members, I attempted it in many; yet so that at first in my budding practice thereof, I alwayes had my cauteries and hot irons in a readinesse, that if anything happened otherwise then I expected in this my new worke, I might fetch succour from the ancient practice, untill at length confirmed by the happy experience of almost an infinite number of particulars, I bid eternally adieu to all hot irons and cauteries which were commonly used in this worke. And I thinke it fit that chirurgions doe the like. For antiquity," he adds, "and custome in such things as are performed by art, ought not to have any sway, authority or place, contrary to reason, as they oft times have in civill affaires; wherefore let no man say unto us that the ancients have alway done thus."[1]

Some twenty years subsequently to the publication of the preceding observations, Ambrose Paré wrote a so-called "Apologie" for certain parts of his published practice and writings, and particularly for the introduction of the ligature of arteries in amputation, etc. By that time he had come to ascertain that various old authors besides Galen had alluded to the deligation of blood-vessels. And as antecedent authorities for the tying of blood-vessels, he cites, besides Galen, a long array of authors, namely—Celsus, Avicenna, Guy de Chauliac, Hollier, Calmetheus, Vesalius, John de Vigo, Tagaultius, Peter of Argillata, John Andreas a Cruce, and d'Alechamp.—(See Paré's "Workes," p. 1134.) None of these authors, however, describe the ligature of vessels as anything

[1] *Paré.*—See his "Workes," pp. 462, 463.

but an occasional and exceptional measure in operative surgery; and none of them explicitly mention it as applicable in amputation, for in the hæmorrhages accompanying that, and most other grave and serious operations, they trusted principally or entirely to the action of burning.

In his account of the siege of Danvilliers, in the year 1552, Paré incidentally gives us a glimpse of what was possibly his earliest case of amputation without heated irons. "At the returne," says he, "from the German campe, King Henry besieged Danvilliers; those within would not render. They were well beaten, and our pouder failed us. In the meane time they shot much at our people. There was a culverin shot pass'd atraverse the tent of Monsieur de Rohan, which hit a gentlemans leg, which was of his traine; which I was faine to finish the cutting off, the which was done without applying hot irons. . . . The campe being broken up, I returned to Paris with my gentleman whose leg I had cut off. I drest him, and God cured him. I sent him to his house merry with a woodden leg,[1] and was content, saying that he scaped good cheape, not to have beene miserably burnt."[2]

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[1] "*Merry with a woodden leg.*"—In this case of amputation, Paré describes his patient as able to use a wooden leg. At the present time, surgeons can little appreciate the importance of this result. For under the old modes of amputation and cauterization, protrusion of the bone and ulceration of the conically-shaped stumps were rife. Paré himself tells us (p. 462) that where cauteries were used, the "combust wounds difficultly come to cicatrization;" and as the bones were laid bare many were "forced for the remainder of their wretched life to carry about an ulcer upon that part which was dismembred; which also tooke away the oportunitie of fitting or putting too of an artificiall legge or arme in stead of that which was taken off." It is no marvel then to find Paré boasting in some individual cases of amputation, which he details in his "Apologie," that his patients, in whom deligation of the arteries was employed in amputation of the lower extremities, could use a wooden substitute for the lost member. In detailing the second case (p. 1136) which he cites, he proudly mentions that his patient was "happily cured without the application of hot irons, and walketh *lustily* on a woodden legge." In the next two cases of amputation of the leg which he describes, he makes a similar boast. In the last century Heister stated, that "after the stump is healed up, the surgeon may provide an artificial limb of *silver* for those who can afford it; or of wood for others."—(See his "General System of Surgery," vol. i. p. 368.) But I doubt extremely if a dismembered millionaire would feel as "merry" with a silver leg as a pauper would do with a wooden substitute.

[2] *Early Amputation case by Paré.*—See his "Workes," pp. 1148,

In his published writings Paré has described two or three different modes in which he was in the habit of securing the mouths of vessels laid open in amputation and other wounds. The *first* of these methods consisted of the seizure of the bleeding point with a pair of pincers or forceps, and applying a ligature above the part caught by the forceps, upon the same principle, and indeed exactly in the same way, as the operation of deligation is usually practised by surgeons of the present day.[1] They employ, however, forms ot

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1149. In the edition of his works on "Gunshot Wounds," etc., published in 1552, Paré still speaks only of arresting the hæmorrhage in amputation by the old method of cauterization. He gives no hint of any other plan. This case of amputation in the text, occurring during the same year, was hence probably one of the first, if not the very first, in which he did not use fire as a hæmostatic.

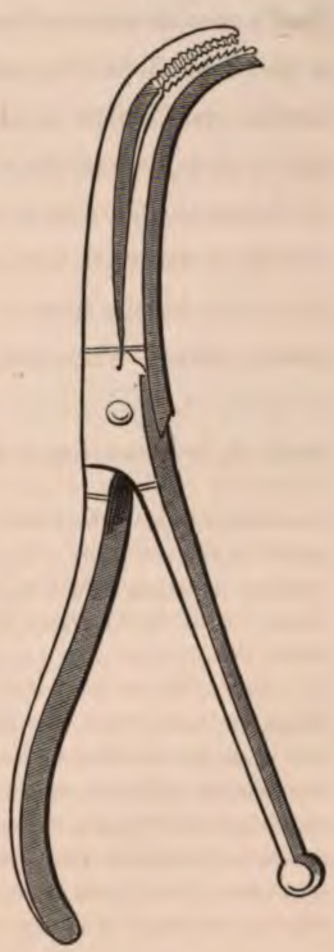
[1] *Paré's chief method of ligature.*—Paré describes, in the following terms, his first and principal method of applying the ligature to arteries in amputation. "When," he observes, "you have cut off and taken away the member, let it bleed a little according to the strength of the patient, that so the rest of the part may afterwards be lesse obnoxious to inflammation and other symptomes; then let the veines and arteries be bound up as speedily and streightly as you can; that so the course of the

artery-forceps more elegant, and more fixed and sure, than those invented and manufactured in

flowing blood may be stopped and wholly stayed, which may be done by taking hold of the vessells with your Crowes Beake, whereof this is the figure:—[See Fig. 16. —"*The Crowes Beake fit for to draw the vessels forth of the flesh wherein they lye hid, that so they may be tyed or bound ast.*"]

"The ends of the vessells, lying hid in the flesh, must be taken hold of and drawn with this instrument forth of the muscles whereinto they presently, after the amputation, withdrew themselves, as all parts are still used to withdraw themselves towards their originals. In performance of this worke, you neede take no great care, if you, together with the vessells, comprehend some portion of the neighbouring parts, as of the flesh, for hereof will ensue no harme; but the vessells will so bee

Fig. 16.



Paré's time; and for the most part they carefully endeavour to avoid including any of the surrounding tissues along with the tied arterial tube. Paré's *second* mode of using the ligature is one which I shall have occasion to discuss at some length in Chapter XVII., under the name of thread-compress or filopressure. It consisted of a strong thread, placed semicircularly round the bleeding artery, and passed by a needle through the intervening tissues externally to the cutaneous surface, where its ends were tied upon a small bolster laid upon the skin. He knew a *third* method, not mentioned in his chapters on ampu-

consolidated with the more ease, than if they, being bloodlesse parts, should grow together by themselves. To conclude, when you have so drawne them forth, binde them with a strong double thread."—(See his "Workes," p. 459.) In his "Apologie," Paré recites several histories of amputation, "to make you beleeve the blood of veines and arteries is surely stanched *without* applying any actuall cauteries" (p. 1138). In describing the first case of amputation which he gives, he tells us that the vessels of the amputated leg were griped by the Crow-bill forceps and tied; "from whence," he adds, "I protest to God (which the company that were there can witnesse), that in all the operation, which was sodainely done, there was not spilt *one porrenger* of blood."—(See his "Workes," p. 1136.)

tation, but notwithstanding sometimes practised by him in that operation, as we learn from his remarks on hæmorrhage, in his book on "Wounds in General." (See his "Workes," p. 328.) The third method consisted of the inclosure of the bleeding point within a circle of ligature introduced by embracing the site of the bleeding vessel with a needle and thread, passed by one or more deep stitches into the surrounding tissue, so that the noose of the ligature, when ultimately tightened and drawn on the raw surface of the wound, compressed and closed the bleeding orifice. This third method of using the ligature—or "stitching" as it was often termed—though now generally discarded from practice, appears to have been much employed in the last century by various eminent surgeons, as Dionis,[1] Garengeot,[2]

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[1] *Dionis.*—"Chirurgical Operations," p. 412. He tied the inclosing ligature, on the surface of the wound, upon a small bolster placed there; so far anticipating the so-called method of Scarpa in the occlusion of the tubes of arteries going to aneurisms.

[2] *Garengeot.*—See his "Treatise of Chirurgical Operations," p. 493; or the original French "Traité des Opérations de Chirurgie," tom. ii. p. 324.

Sharp,[1] Monro,[2] and others,[3] both after amputations, and in other operations.

The proposition of Paré that surgeons "bid eternally adieu to all hot irons and cauteries" in amputations, met, at the time, with few or no followers; and his beautiful and simple suggestion of using nothing but the deligation of arteries in amputation-wounds, etc., seems to have excited little, except the strong ire and bitter persecution of most of his contemporaries. They opposed him in every possible way; they attacked him in their writings; they petitioned the French Parliament to prevent the dissemination of his works. Without deigning even to name Paré, M. Gourmelen, Professor of Surgery to the Faculty of Medicine at Paris, strongly and spitefully denounced him and his invention in a work on the principles of surgery, which he published in 1566. M. Gourmelen and other surgeons had been so long accustomed to their caustics, and were so entirely and so perfectly satisfied with *their* power and effects, that they wanted no such disturbing innovation as this ligature. "It was then," writes Gourmelen, "very forward, rash, and presumptuous in a certain person to venture upon condemning the cauterizing of bleeding vessels (after cutting off a mortified limb)—a method so highly and continually commended and approved of by all the ancients; teaching, in opposition to that, without any authority, without knowledge, without experience, without good sense, some new method of his own, of tying arteries and veins."[1] This same argument of the old Parisian professor—and in nearly the same words, too—was employed two or three years ago in the Medico-Chirurgical Society of London, when the subject of acupressure happened to be brought before them.[2]

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[1] *Sharp.*—"The ligature," he observes, "with a crooked needle pass'd twice through the flesh, almost round" the extremities of the vessels, "will, when the knot is made, necessarily inclose them in the stricture. This is a much better way," he adds, "than using the artery-forceps, where the vessels are apt to slip away out of the ligature."—(See his "Treatise on the Operations of Surgery," 3d edit. p. 318.)

[2] *Monro on amputations of the limbs in Edinburgh in the earlier half of the last century.*—The first Professor Monro, in a masterly memoir "On the Amputations of the Larger Extremities," contained in the 4th volume of the Edinburgh Medical Essays, states, that stitching the vessels with a needle and thread is "now [A.D. 1752] universally practised among us," and is preferable to the use of the artery-forceps. In this memoir as given in the 4th, but not in the 1st edition of the "Medical Essays," he states, that in the Royal Infirmary of Edinburgh, out of 99 patients whose limbs were amputated, only 8 died, or 1 in 12, a result which is striking and remarkable. Two of the fatal cases were apparently instances of primary amputation, and the other deaths were after secondary amputation.—(See the "Medical Essays and Observations," 4th edit., vol. iv. pp. 263 and 276.)

[3] *On stitching.*—See, in addition, the writings of Petit, Heister, Gooch, Louis, Bell, etc.

Paré's proposal for the deligation of the bleeding arteries in amputation, spread very, very slowly. Even his favourite pupil, Guillemeau, to whose evidence in favour of the ligature Paré himself had directly appealed, and who translated Paré's works into Latin, ultimately declared his preference for the old orthodox cauteries in all cases, at least, of gangrened limbs requiring to be amputated.[3] In his work termed—"La Chirurgie Françoise," he gives a magnificent folio plate of some twelve different cautery-irons, which the surgeon may use—their beaks or ends being represented of all imaginable shapes in order to be able to reach and burn the proper bleeding points and parts. For it is to be remembered, that the ancient surgeons boasted themselves mightily of the variety and numbers of their cautery-irons. "The moderns," writes Guy de Chauliac, "have reduced them to a determinate number: William of Salicetus, for instance, to six or eight; Lanfranc to ten; Henricus to seven. I, however, have made the common cauteries of six forms."[1] In these respects it is evident that Guillemeau, the disciple, the friend, and the successor of Paré, was not behind his olden predecessors.

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[1] *Gourmelen.*—See J. Bell's "Principles," vol. i. p. 160; Paré's "Workes," p. 1133; or Gourmelen's "Guide des Chirurgiens," p. 158.

[2] *The same argument.*—See "Medical Times and Gazette" for April 28, 1860, p. 425, and May 5, 1860, p. 459; and the "Lancet" for May 5, 1860, p. 446.

[3] *Guillemeau's preference for cauteries in some forms of am-*

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putation.—When speaking of Guillemeau's practice, O'Halloran shrewdly observes, "As the patrons of fire were at this time very powerful, he [Guillemeau] attempts a medium to please both parties. He says, in all sudden accidents the ligature is best; but in tedious cases, where there is any suspicion of the gangrene's remaining, he there recommends the cautery."—(See "Complete Treatise on Gangrene," etc.; Introduction, p. xxiii. See also Dr. Thomson's "Lectures on Inflammation," p. 272.)

[1] *Number of cauterizing irons.*—See Guy de Chauliac's "Chirurgia," Leyden edit., 1572, p. 470. "A precious employ-

The opposition to the ligature in amputations was not confined to Paré's Parisian contemporaries and immediate successors. Dionis describes for us the hæmostatic means used in the Hotel-Dieu of Paris—the hospital in which Paré studied, and the city in which he lived and practised—a century and half after he first proposed the deligation of arteries in 1564. Up to the time at which Dionis published—namely 1707—the orthodox surgeons of the Hotel-Dieu still rejected the ligature in amputations, and stopped the hæmorrhages in amputations by caustics or the vitriol button. Dionis himself, however, pleaded for and used the ligature, though he had not yet absolute faith in it; for he adds, that "if the ligature happens to fail we have recourse to vitriol buttons," made of bits of broken blue vitriol, wrapped up in a little cotton.[1]

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ment, indeed," observes John Bell, "for Gulielmus de Salicetus, Henricus, Lanfranc, and Guido de Cauliaco, *counting* their burning-irons !"—(Principles of Surgery, vol. i. p. 150.)

[1] *Dionis.*—See his "Cours d'Opérations de Chirurgie," Brussels edit., 1708, p. 508, etc. The slowness with which deligation was adopted in amputation in Paris is perhaps the more remarkable,

Matters did not progress more rapidly elsewhere. During the seventeenth century the surgical writings of Fabricius ab Aquapendente in Italy, and of Hildanus in Germany, "were," says Mr. Sharp, "esteemed almost as Oracles."[1] Both of these great authors — and the surgical schools which they represented — were opposed to the ligature of arteries in amputation as a means deserving of professional confidence. Fabricius[2] indeed acknowledges the dreadful uncertainty that existed in regard to the arrestment of hæmorrhage in am-

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as some thirty years before the date of Dionis's writings, or in 1674, another French surgeon, Morel—throwing aside the old fillet so long used in amputation—invented, at the siege of Besançon, the first form of the true tourniquet, for restraining the bleeding in amputations, till other hæmostatic means were duly applied to the mouths of the divided vessels. A few years subsequently Mr. Yonge, an English surgeon, in his work, "Currus Triumphalis è Terebintho," written in 1678, but not published till the following year, described a rude tourniquet like Morel's, the pad of it being composed of a "wadd of hard linen cloth, or the like." The more finished and elaborate tourniquet of M. Petit, in which the screw was substituted for the turn-stick, was not given to the profession till 1718.

[1] *Sharp.*—"Critical Enquiry into the Present State of Surgery," 4th edit. p. 305.

[2] *Fabricius ab Aquapendente.*—See *ante*, p. 3.

Fig. 17.

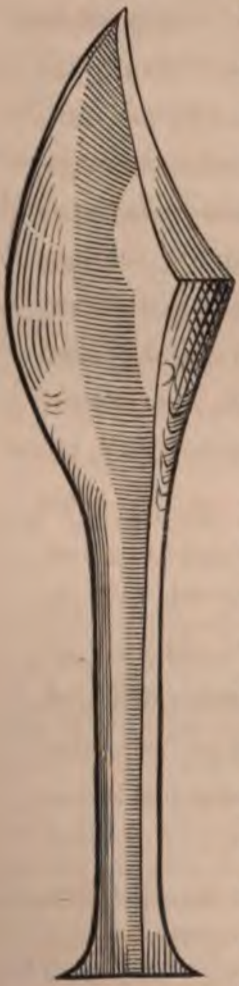

Fig. 17. The *Cauterium Cultellare* of Hildanus.

putations, and recommends in consequence — not deligation — but the dismemberment of the gangrened limb through the mortified and bloodless parts. Hildanus had recourse to the resuscitation of an old device to surmount the difficulties connected with hæmorrhage in amputations. Opposed to the practice of the deligation of arteries, he recommended the dismemberments to be effected by a large red-hot knife, which at one and the same time severed the soft parts and sealed up the bleeding orifices on their cut surfaces. He gives a reduced woodcut of this grim and ugly "*Cauterium Cultellare*" of his, copied in Fig. 17; and he expresses himself with almost affectionate enthusiasm regarding its "egregiæ virtutes,"—its exquisite operative and hæmostatic powers. "Porrò," he exclaims, "excellentiam hujus Cauterii non satis extollere possum!" He duly describes, however, the application of the cautery-irons also after amputation and other wounds with the common knife, and recommends that in practice the red-hot iron should be pressed strongly and rapidly against the bleeding surface—"fortiter admovendum est." He refines still farther in the same direction, and argues that the surgeon should if possible be ambidexter, for then, holding a red-hot iron in each hand, he was thus able to apply them both at once so as to grill and char the whole raw wound with duly artistic expedition. Hildanus gives also, like Guillemeau, and other authors, a drawing of the sick-room and bed of an amputation patient, with a sketch of the position of the patient himself during the operation, of the operator and his assistants, of the leg that is being amputated tied upon a supporting stool, and the saw applied to the bones; with the table spread with apparatus and dressings, etc., and a burning chaufer in the corner with the cauteries commonly used heating in its flames. The accompanying woodcut (Fig. 18) is an imperfect and reduced copy of the plate of Hildanus.[1]

Fig. 18.

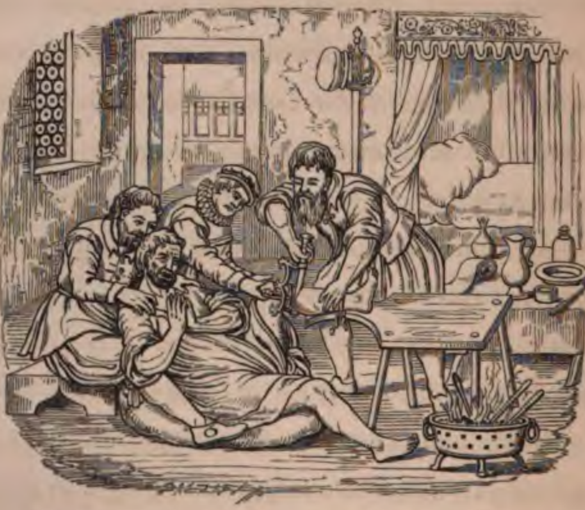

Fig. 18. Old amputation scene. Reduced from Hildanus.

If Hildanus was a correct representative of German surgery in the seventeenth century, the same character may perhaps be justly attributed to Heister, as a surgical writer, in the earlier half of the last century. Writing in 1739, Heister, in all probability at least, correctly represents in his celebrated "Institutiones Chirurgicæ," the state of opinion and practice at that date in Germany regarding the means of arresting hæmorrhage after amputation; and he recommends in amputation of the thigh, for example, the mouths of the larger arteries to be tied up with strong thread, but "for the smaller arteries," he adds, "it may be sufficient to close them by styptics or vitriol and dossels of scraped lint without ligature."[1]

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[1] *Hildanus.*—See his "Opera," Frankfort edit. of 1646, pp. 809, 812, 813.

In Holland, in 1692, the celebrated anatomist and surgeon Nuck, President of the Leyden College of Surgeons, still disapproved altogether of the ligature of vessels, declaring it a mode of arresting hæmorrhage both difficult to the surgeon and painful to the patient.[2] In fact, on the continent of Europe generally, the innovation of Paré was long systematically resisted, and every kind of cauterization, astringent, absorbent, and styptic, etc., was anxiously tried rather than have recourse to deligation, especially in amputations. "A remarkable point in the history of amputations is," says M. Dezimeris,[1] "the difficulty with which people came to forget the cauterization of vessels for the ligature of them, and all the thought and research they expended in order to excuse themselves from having recourse to the latter method. One might boldly affirm that of the number of amputations which were performed during the two centuries that followed the discovery of Paré, two-thirds at least were done without ligature. To arrest the blood, Felix Würtz employed the powder of puff-ball; Brossard, Morand, Theden, and many others, the agaric of oak and compression; Borel and Solingen a button of vitriol; Maggi, and afterwards Verduin and Sabourin, regarded the immediate firm closure of the wound as sufficient—an opinion revived by Koch the father, and supported by his son and by some others."[1]

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[1] *Heister.*—See his "General System of Surgery," vol. i. p. 367. The "vitriol and dossels of scraped lint" formed, of course, the old hæmostatic Vitriol Buttons.

[2] *Nuck.*—See his opinion in the original Latin, already quoted at p. 143.

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[1] *Dezimeris.*—See the "Dictionnaire de Médecine ou Répertoire Général de Sciences Médicales," 2me. edit., tom. ii. p. 482.

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[1] *Koch's practice of preventing hæmorrhage in amputations by compression.*—The surgeon to whom M. Dezimeris last refers, namely Dr. Koch, formerly Director of the General Hospital at Munich, averred that he had not tied a single artery in the various amputations he had performed for twenty years.—(See his work, "De præstantissima Amputationis Methodo," Landschut, 1826.) His observations are at all events interesting, as showing what a small amount of systematised compression is generally able to prevent hæmorrhage. His method of preventing hæmorrhage in amputation, as stated by his son, is as follows:—"After dividing the soft parts and bone, the surface is sponged, and the muscles and integuments brought neatly into contact, and retained by adhesive plasters, so as to secure adhesion by the first intention, if possible. *During* the operation the [main] vessel is compressed by the fingers of an assistant; and *afterwards*, the pressure of the fingers is rendered unnecessary by the application of a compress laid along the trajet of the main artery, secured by a roller. The patient is then placed in his bed, and the stump kept elevated; and an assistant is directed to make gentle pressure on the face of the stump for an hour or two—or longer if he feel considerable pulsation in the part. When," adds M. Koch, "this pulsation has ceased, and when the dressings appear tinged red by the exuding lymph, all danger of hæmorrhage is considered as at an end, provided the patient keeps quiet."—(See the "American Journal of the Medical Sciences" for February 1828, p. 463; or the "Journal des Progrès," tom. xii. p. 248.) The dangers of Koch's practice have been shown, according to M. Velpeau, both by the evidence of M. Graefe at Berlin, and by Dr. Koch's own son.—("Operative

In England the ligature of vessels was long stoutly opposed and objected to, as it was elsewhere

Surgery," Amer. edit., vol. i. p. 46.) "It is," observes Chelius, when treating of amputations, "incomprehensible that, in the present time, there should still be some who, instead of the simple and safe practice of tying, employ the constant applicatione of cold water; or [in allusion to Koch], in flap-amputations, the compression of the principal arteries in the flap against the bony stump."—("System of Surgery," vol. ii. p. 894.) The other authors besides Koch, to whom Dezimeris alludes as trusting to compression to avert hæmorrhage in amputations—namely, Maggi, Verduin, and Sabourin—all fancied that they might occasionally restrain the flow of blood from the orifices of the open vessels, by strongly compressing and binding the surfaces of the amputation-flaps against each other, or against the end of the stumps. Maggi's imperfect remarks on this subject were written upwards of three centuries ago.—(See his treatise "De Vulnerum, etc., Curatione," in Gessner's "Scriptores Veteres," p. 268.) In reference to the results of Verduin's and Sabourin's practice, O'Halloran remarks, "It was laid aside on account of the monstrous hæmorrhagy and for want of success."—(See his treatise on "Gangrene," etc., p. 209.) Other authors speak of arresting the hæmorrhage in amputation by similar compression and stitching of the stump. See, on this idea, Severinus, in his work, "De Efficaci Medicinâ," Frankfort, 1646, p. 128. "If the flux," says William Salmon, "be great, and the patient refuses the actual cautery; then, as soon as the member is taken off, let the skin, together with the flesh, in four distinct places, opposite one to the other, be taken up with a needle and waxed thread, and the ligature loosned above, or drawn down, that if possible they may meet. This way is painful and troublesome, and therefore in Europe. Paré's English contemporary Gale, who was surgeon with the army of Henry VIII., at Montreuil, lamented, as we have already stated, the use of "actual cauterizing yrons which sore feared the people with the orror of cauterization."[1] But the celebrated Richard Wiseman, sergeant-surgeon to Charles II., still continued to use cauteries and caustics to suppress the hæmorrhage in amputations, for though the ligature was known to and described by him, yet there is no evidence that he ever adopted or employed it in his amputations.[2] Dr. Salmon of London, in his "Ars Chirurgica," published in 1698, speaks only of the deligation of arteries as "very troublesom and not mightily approved of now."[3] He gives a figure of the amputation of the hand by the chisel and mallet (see Fig. 19), as practised in his day, and another of the mode of arresting hæmorrhage in

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seldom to be used, yet *it stays* the hæmorrhage, preserves the bone from all danger, and makes the wound to be the sooner cured."—(See his "Ars Chirurgica," p. 94.)

[1] *Gale.*—"Certain Workes of Chirurgerie," p. 63.

[2] *Wiseman.*—See his "Chirurgical Treatises," p. 453.

[3] *Salmon.*—See his "Ars Chirurgica," p. 771.

amputation of the foot by the actual cautery, which is copied in woodcut Fig. 20. Such was surgery in England less than two centuries ago; and we need scarcely marvel that a somewhat later writer on surgery should indignantly complain, that "the common opinion is, that chirurgeons desire nothing more than cutting and

Fig. 19.

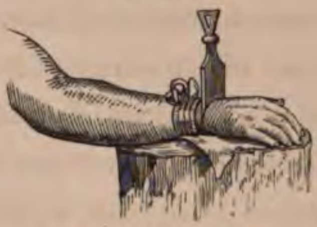

Fig. 19.—Amputation of the hand by the chisel. (From Salmon's "Ars Chirurgica," Tab. XII.)

Fig. 20.

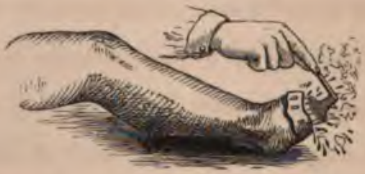

Fig. 20.—Application of the actual cautery to the surface of the stump after amputation of the foot. (From Salmon's "Ars Chirurgica," Tab. XII.)

hacking, and their joy is at the highest pitch when, with the cutting instruments in their hands, they have a glut of hacking work."[1]

In the most popular English surgical work of the last years of the seventeenth century, Mr. Cooke, when treating of that "dreadful operation," the amputation of limbs, tells us that it is done "with the dismembring-knife, which some use red-hot;" and he speaks of three modes for stanching the resulting hæmorrhage—first, potential caustics; and secondly, "actual cauteries," which are, he says, "to be applyed to the mouth of the vessels, being cleansed from clotted blood once or twice at most. The third way," he contemptuously adds, "is by stitching, which is almost wholly rejected. See Pareus for the manner."[2]

In the sixth edition of his "Art of Surgery," published at London in 1741, Daniel Turner tells us, that at that date the ligature of arteries, "where the same can be come at, is *now* frequently practised upon dismembring, and performing certain other chirurgic operations." As a hæmostatic caustic, "if the ligature cannot be perform'd," he praises turpentine "boiling hot," as an excellent restringent to the blood; and he avers further, that its application does not give half so much pain as some other escharotics.[1] In the Edinburgh Hospital Professor Monro states, in 1747, that "the most common practice is now to stitch the vessels;" and in 1752 he adds, deligation is "now universally practised among us."[2]

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[1] *Hacking work.*—Dionis's "Chirurgical Operations," p. 403.

[2] *Cooke.*—See his "Mellificium Chirurgiæ, or the Marrow of Chirurgery," 4th edit., 1693, pp. 202, 203.

Writing after the middle of the last century, the excellent London surgeon Mr. Samuel Sharp[3] observes that it was only within the preceding half century that the barbarous practice of using red-hot irons, potential caustics, powerful astringents, and "poisonous applications, as arsenic and corrosive sublimate" (p. 298), in the arrestment of hæmorrhage, had by degrees fallen into disuse both in France and England, but it was not yet (1761) "discarded in every part of Europe" (p. 306). Some practitioners in England seem still to have used cauterization for the smaller vessels, " after tying up two or three of the largest" (p. 309). "The great danger and uncertainty," says he, "attending these methods of stopping the blood having at last opened the eyes of several eminent surgeons, the use of the needle and ligature has by degrees crept into practice" (p. 299). But Mr. Sharp still complains, in 1761, that the ligature was "not received with that universal acceptation one would wish and expect" (p. 304); and in the way of apology for enforcing in his work the advantages of the ligature he adds, "improvements of all kinds are so slowly propagated that this, amongst others, is not universally practised in the distant counties of our own kingdom" (p. 314).

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[1] *Turner.*—See his "Art of Surgery," pp. 343-345.

[2] *Monro.*—"Edinburgh Medical Essays," 3d edit., vol. iv. p. 262; and footnote *ante*, p. 194.

[3] *Samuel Sharp.*—See his "Critical Enquiry into the Present State of Surgery," 4th edit., London, 1761.

It is certainly not flattering to the boasted march of professional knowledge in our own country that such observations as the above required to be made in England two long centuries after Ambrose Paré had publicly proposed and practised the deligation of arteries.

It is not my duty here to discuss—even had I the ability to do so—the many modifications that surgeons have from time to time suggested as to the forms, shapes, directions, etc., of the wounds made in amputation, with a view to the safety of their patients, the formation of good stumps, and the rapidity of their cure. In the olden days of surgery, the knife seems to have been sent down direct to the bone, with little or no attempt at the formation of a covering for the wound; and the practice has not entirely disappeared in this century. Sir Charles Bell tells us, that after the battle of Waterloo he saw some stumps made in this old rude fashion. On examining one of these cases, " there came off," says he, " a round cake of charpie, which corresponded with the face of the stump. The stump itself was one uniform flat surface—integument, muscle, and bone forming one plane, as you may see in a hamshop."[1] I have heard of stumps of this fashion after battles much later than that of Waterloo. But the leading members of the surgical profession have long and anxiously striven to shape their amputation-wounds so as to cover fully the end of the bone, and expedite the cure. Many modifications in this way, of circular and flap, of ovalar and rectangular, etc., amputations, have been introduced, from the time of Yonge, Verduin, Sabourin, Louis, Cheselden, Alanson, and others, during the seventeenth and eighteenth centuries —down to the more recent efforts in the same direction, of Teale, Spence, and Carden, in our own day. The general problem, however, of the best possible form of stump in amputation is perhaps not yet quite solved; and its solution must require to vary with the varying conditions of the limb operated on, and the injury or disease for which the operation is performed. The problem itself is one which involves three leading conditions—namely, the kind of amputation-wound or stump which is (1.) safest as far as the life of the patient is concerned; (2.) most favourable for healing by the first intention, and for effecting a speedy cure; and (3.) most serviceable afterwards in its toleration and use of an artificial limb. Hitherto the application and presence of the ligatures in the depths and between the lips of amputation-wounds, have so far absolutely prevented the full and entire accomplishment of the second of these conditions (see *ante*, p. 70)—as at the site of ligation, and along the tracks of the ligatures, adhesion is impossible so long as the threads remain. The use of acupressure, however, has already, in several instances, enabled surgery to take a step forward in the treatment of amputation-wounds, and to effect their complete cure by primary union—as is proved by the cases which we have already detailed in Chapter VII. And subsequently we shall have occasion to see that it is destined, perhaps, to contribute also, in some respects, to the fulfilment of the first condition named—viz., by adding to the safety of the life of the patient.

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[1] *Sir Charles Bell.*—"Institutes of Surgery," vol. i. p. 336.

CHAPTER XIV.

RETROSPECT OF THE MODES OF ARRESTING HÆMORRHAGE AFTER REMOVAL OF THE MAMMA.

THE history of the removal of the mamma, in cases of cancer, etc., affords, like amputation, a striking example of the series of changes which surgery has gradually undergone in relation to the arrestment of hæmorrhage in operative wounds; and, let me add, in relation also to the character and treatment of the accompanying wounds themselves.

Of course it is not a question with us at present whether extirpation of the mamma should be ever, or never, or often had recourse to, in cancer and other maladies. Nor have we to discuss all the possible modes of extirpation. The diseased breast has been often and entirely removed by the application of cauteries and strong caustics alone;[1] but these means do not fall within our present consideration, for the object of this chapter is to mention the chief modes of removing the diseased mamma that were liable to be followed by hæmorrhage, and to specify the modes by which that hæmorrhage was attempted to be averted or arrested.

In the past history of surgery we find two or three different modifications of operations for the extirpation of the mamma, before we reach the mode of cutting down upon and dissecting out the tumour which is generally practised at the present day. The ancient methods may be stated as follows:—

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[1] *Actual cauteries for destruction of the diseased mamma.*—When the actual cautery was used for the purpose, it required to be done as directed by Wiseman, "not by applying it lightly upon the upper parts, but by thrusting at the root with a scoop or chisel-like cautery, carrying it away before you. If there remain any rags of it, with a proportionable button-cautery burn it down to a crust."—("Several Chirurgical Treatises," 1676, p. 105). A still older English surgeon—namely, the celebrated John of Gaddesden—recommends the extirpation of cancer to be effected with a heated *golden* cautery (*fiat cauterium cum auro ignito*), as if the mere price of the metal used could either enhance its surgical effects or afford any anæsthetic solace to the patient.—("Rosa Anglica; Practica Medicinæ a capite ad pedes," 1491, fol. 162.)

(1.) *Cautery-Knives.*—In the excision of the mamma, as in amputation of the limbs, there were sometimes used by the ancient surgeons knives which were cunningly calculated at one and the same time both to remove the diseased part and to arrest the hæmorrhage. Thus, in one of the reputed works of Galen, this double attribute is ascribed to a razor heated in the fire.[1] And the same idea had not died out even in the seventeenth century. "If," says Fabricius ab Aquapendente, "the cancer be movable, I should grasp it with the forceps, and forthwith perform the extirpation with an incandescent knife (*cultro candenti*); in order that the cancer may be amputated by the sharpness of the knife, and the bleeding at the same time suppressed by its glowing heat." Fabricius had still another, and if possible more relentless, mode of extirpating a cancerous mamma, in cases where the diseased mass was adherent and fixed, and could not be seized and lifted up with the forceps. He advises, under this complication, that we should avert the pain and loss of blood by first hacking through the whole skin and circumference of the tumour with a sharp piece of wood or horn (*ligno aut cornu aciem habente*) soaked from time to time in *aquafortis*—and then tear out the glandular substance of the mamma from the subjacent part with the fingers and nails. If the discharge of blood obscures the operation, the vessels are to be occluded with burnt bombyx; and afterwards, if need be, the resulting bleeding is to be arrested with red-hot irons (*ferramentis candentibus*). But there is a danger, he warns us elsewhere, of the fire burning too deep, and affecting the heart itself.[1]

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[1] *Galen.*—See his "Opera," Kühn's edit., tom. xiv. (*Isagogue*, cap. xix.), p. 786.

(2.) *Alternate Applications of the Scalpel and Cautery.*—One of the earliest modes in which the cutting and unheated bistoury was used for the removal of the cancerous mamma, was in reality not less pitiless than the preceding plans with the red-hot scalpel or aquafortis-knife. The first full description of the operation for the removal of a cancerous mamma is to be found in the "Tetrabiblos" of Aëtius, who cites the description of the operation as performed by Leonidas, a surgeon of the early part of the fifth century. He directs an incision to be made into the substance of the mamma at the site of the cancer, and the actual cautery to be immediately afterwards thrust into the incision until an eschar be produced and the attendant bleeding stopped. He then orders to be immediately made still further into the substance of the mamma a second and deeper incision, which is to be immediately cauterized like the first; and so onwards, with a series of successive incisions and searings—with the alternate use of scalpel and fire—till the whole cancerous mass were removed. These repeated cauterizations with the red-hot irons, which thus are ordered to follow every fresh stroke of the dissecting-knife, were merely for the purpose of restraining the attendant bleeding. But after the amputation of the diseased mass was completed, and the bleeding arrested, Leonidas again further charred and burned more completely the remaining parts until they were quite dry and scorched, with the hope and object of eradicating all remnants of the malady.[1]

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[1] *Fabricius ab Aquapendente.*—"Opera Chirurgica," Leyden, 1723, fol. 123 and 503.

(3.) *Slicing off the whole Mass, and then applying Cauteries, etc. etc.*—Very many of the old and mediæval surgeons,[2] without recommending the rush of blood following each new individual gash of the knife to be arrested by a new application of the red-hot cautery-irons, effected first the complete excision of the diseased organ, and then subsequently applied their cauteries, caustics, or other hæmostatics, to the extensive resulting bleeding surface, till the hæmorrhage was stanched and restrained.

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[1] *Leonidas.*—See the "Tetrabiblos" of Aëtius, tetr. iv., serm. iv., cap. 45. Soranus describes the same operation in almost the same words (see Adams' translation of Paulus Ægineta, vol. ii. p. 333).

[2] *Plans of old surgeons.*—"Some," says Paulus Ægineta, "have consumed the whole redundant matter by cauteries, but others first make an excision of the whole breast and then burn the place."—See the "Seven Books of Paulus Ægineta," translated by Dr. Adams, vol. ii. p. 332.

The diseased mamma, under this plan of treatment, was entirely sliced off by one or two huge and rapid incisions through its base. Ere the simple grasp of the hand was mainly trusted to, various ingeniously merciless devices were employed to hold the diseased mass steady and outstretched whilst the stroke for this swift and rough process of amputation was inflicted. For this purpose, one of the oldest methods followed consisted, as represented in the plates of Scultetus and Heister,

Fig. 21.

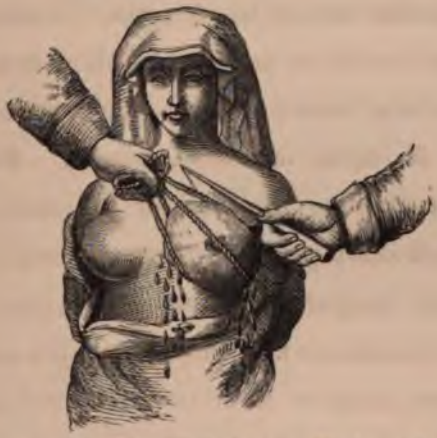

Fig. 21. The process of slicing off the breast. The breast itself transfixed with two cords, and dragged forwards.—(After Scultetus and Heister.)

in transfixing the breast with two threads or cords introduced crosswise to each other (see Fig. 21); a plan described and praised also by Nuck. The diseased part was pulled outwards by traction upon these cords, and then the wholesale extirpation of the entire mamma—gland, skin, and all—was effected by cutting behind the cords or through the base of the tumour. To lift and hold out the breast, Solingen and Bidlow transfixed it with a large strong fork, the prongs of which were seven or eight inches in length. Bidlow, in smaller cancers, employed for the same object a flattened sharp-pointed instrument, which Heister correctly compares to a small-sword, effecting with it the transfixion and elevation of the mass. For the same purpose Helvetius contrived great pincers, the sharpened beaks of which were ruthlessly dug into the sides of the mammary mass to hook and hold it up; and this instrument of Helvetius was long in fashion and much employed and lauded by European surgeons. Tabor,[1] Hartmann, and Vylhoorn, used for the purpose a special instrument or machine, which was intended for the double function of both fixing and slicing off the breast. It consisted of a jointed circlet of iron made so as to close and tighten upon the basis of the mamma that was to be removed; and then subsequently a knife, of the shape of a sickle or half-circle, by a strong and swift motion of the handle shaved off the whole diseased mass.

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[1] *Tabor.*—See his "Dissertatio de Cancero Mammarum,"

After the entire mass of the cancerous mamma was removed by the knife or any of its cutting substitutes, the gush of blood from the vessels exposed on the surface of the resulting circular wound was arrested by hæmostatic applications of various kinds.

(*a*.) *Cauteries.* — The application most commonly resorted to consisted of the actual cautery, freely, fully, and rapidly applied to the surface of the wound, and more particularly to the bleeding points of it. The figure, copied from Scultetus, in

with a plate, in Haller's "Disputationes Chirurgicæ," tom. ii. p. 451, *sqq.*; or Heister's "System of Surgery," vol. ii. p. 63. Both Tabor and Heister describe the different modes of seizing the mamma for extirpation, as practised by different surgeons.

the annexed woodcut, Fig. 22, is one illustrative—after the operation in question—of the application

Fig. 22.

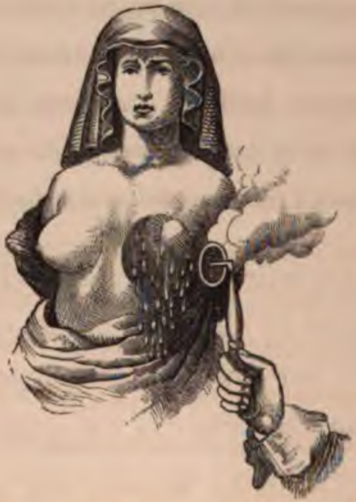

Fig. 22. The application of the red-hot cautery to the bleeding surface of the wound resulting from amputation of the mamma (Scultetus).

of red-hot irons. "As to the use of which," Daniel Turner duly warns us, "there may be more judgment required than the younger Artist is aware of; for if perfectly red, or fire-hot as we call it commonly, hastily applied and instantly remov'd, it is odds but at the same time the eschar or crust is pulled off with the iron, and the patient under-goes the pain to no purpose—the vessel now again bleeding as forcibly as ever. When the same, then, is of a moderately glowing heat, being struck against the grate, or side of the chafing-dish, where the burning charcoal is kindled for that purpose, and rub'd against the floor; let it be strait clap'd up to the mouth of the artery—carrying it, however, sideways to the same, that the blood flowing out against or upon it, may not damp the heat. At the same time, let the end of the cautery be turned two or three times round about against the bleeding part, with expedition; still observing, upon each touch, whether the work is done complete, whence you may renew or wholly withdraw your instrument, conveying the same, as it was brought you, *handsomely* out of your patient's sight."[1]

(*b.*) *Caustics, etc.*—Sometimes, particularly when the bleeding was not very great, it was tried to be staunched by chemical caustics, as vitriol buttons or pieces of sulphate of zinc and alum, corrosive sublimate, etc.; or by astringent and styptic lotions and powders of many different kinds.

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[1] *Turner.*—See his "Art of Surgery," 6th edit., 1741, p. 527.

(*c.*) *Compresses.*—Occasionally, when the attendant hæmorrhage was not severe, compresses, simple or medicated—as sponge, agaric, etc.—were trusted to. The compresses, when sufficient, were kept applied, sometimes by the hand alone, more frequently by bandages, and occasionally by stitches crossed from one side of the wound to the other.

(*d.*) *Ligatures.*—The deligation of the bleeding vessels after excision of the diseased mamma was longer in being admitted into practice than was the case in amputation-wounds. In his chapter upon the removal of cancers, even Paré himself does not recommend the attendant bleeding to be restrained by their use. He advises that "the place must be seared with an actuall cautery; for that will strengthen the part affected, draw forth the venenate quality, and also stay the defluxion."[1] During the next century and a half no surgical writer, so far as I can remember, ventures to recommend the deligation of the arteries in the place of cauterization after the removal of an enlarged and diseased mamma.

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[1] *Paré.*—See his "Workes," p. 281.

In the earlier years of the eighteenth century, Dionis—who did so much to introduce the ligature of arteries after amputation—did not trust to the same means after mammary extirpation. Speaking of the excision of the enlarged mamma by the usual method of a single slice, he describes its facility by a quaint comparison; "this operation," says he, "is easier than is imagined before 'tis performed; for the breast separates as easily from the ribs as when we divide the shoulder from a quarter of lamb." To stem and stay the attendant flow of blood, if it be too abundant, he applied small vitriol buttons to the bleeding orifices, and made use of astringent powders. In arresting the hæmorrhage "we have given over," Dionis further observes, "the use of the searing-irons, called fire-buttons, and that of the red-hot flat iron which was formerly appropinquated to the wound to dry and consume the rest of that voracious acid which was believ'd to have remain'd;" for "these hot irons," he adds, "make the patient *tremble*,"[1]—and no wonder;—it being here difficult or impossible in practice to obey the subtle injunction we have quoted in a preceding page from Turner, of passing and repassing the hot cauteries "handsomely out of your patient's sight." And we doubt not that Read was right when he stated—as one reason against the use of the actual cautery—that "it is horrible to the sight and apprehension; for it doth in a manner exanimat cowardly persons."[2]

Some years subsequently to the publication of these observations of Dionis, we find his countrymen Le Dran and Petit speaking of the deligation of the bleeding arteries after the excision of the mamma, as still an alternative measure only, which was occasionally to be followed. Writing in 1742, Le Dran describes the attendant hæmorrhage as frequently producing actual fainting, for which the patient is to be placed in the supine position till she comes to herself. If with her recovery "the bleeding," he adds, "returns, it must be suppressed, either by making a ligature upon the vessels, or by the application of a small pledget dipt in styptic water."[1] In a similar spirit Petit states, that he has rarely or never been under the necessity of serving himself with the ligature of the arteries after excision of the mamma; for—in consequence of the resistant firm basis of the wound—compression and cauterization with a button of alum have in his hands proved sufficient.[2]

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[1] *Dionis.*—"Course of Chirurgical Operations," p. 255.

[2] *Read.*—See his "Treatise of Wounds," 1638, p. 14.

In Germany the deligation of the arteries, after extirpation of the mamma, was, in the early half of the last century, a practice not much more followed than in France. The actual cautery was in general discarded; but—as in amputations—the ligature was a means employed to secure the larger vessels principally or only,—caustics, styptics, absorbents, etc., being still retained for the closure of the smaller vessels in the wound. Thus, the great German surgical authority, Heister, in 1739, states, as the practice of himself and of his school, that to stay the hæmorrhage, after extirpation of the mamma, the actual cautery was not "necessary." "It may be sufficient only," he observes, "to tie up the larger vessels," and for the remaining bleeding "to apply a large quantity of scraped lint, retaining it with a thick and broad compress, and a long bandage; though," he adds, "my quondam preceptor Bidlow, who was well versed in these operations, advises to sprinkle fine powder of plaster of Paris upon the lint, to stop the hæmorrhage. Others advise styptic powders."[1]

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[1] *Le Dran.*—See Gataker's translation of his "Traité des Opérations de Chirurgie," p. 303.

[2] *Petit.*—"Traité des Maladies Chirurgicales," 1774, tom. i. p. 231.

As early as the sixteenth century, the distinguished Italian surgeon, Fallopius, published an account of the extirpation of cancerous tumours from various parts of the body, in which he recommended the elliptical incision, the dissecting out of the diseased mass, the arrestment of the bleeding by vinegar and cold water, and the subsequent laying and stitching together of the lips of the wound, as if he expected their primary union.[1] His countryman, Ange Nannoni of Florence, published a memoir in 1746, in which these same principles of Fallopius were applied to the operation of the excision of the cancerous mamma—the skin being saved with the hope of reuniting the wound by the first intention ; and with that object sutures were employed.[2] Pallucci, another Italian surgeon, while resident in France, tried, in 1750, to prove—from watching the practice of M. Morand of Paris—that after extirpation of the breast, styptic powders and compression do not suffice always to arrest the hæmorrhage, and that it is better, in most cases, to have recourse to the ligature, because the arteries are much augmented in size.[1]

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[1] *Heister.*—See his "General System of Surgery," vol. ii. p. 61.

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[1] *Fallopius.*—See his " Opera Omnia," Frankfort, 1600, tom. ii. p. 265, or tract ix. cap. v., " de tractatione cancri quo ad locum affectum per medicamenta, et etiam per manualem operationem."

[2] *Nannoni.*—See his " Trattato Chirurgico dell Malattie dell Mammelle," Firenze, 1746. I regret that I cannot state what hæmostatic means Nannoni used, whether the ligature or not, as I have only seen the brief and imperfect analysis of his memoir which is contained in Sprengel's " Histoire de la Médecine," tom. viii. p. 449. Franciscus Arcæus, a Spanish surgeon, and a contemporary of Fallopius, deserves notice for recommending, in his very elaborate account of extirpation of the mamma, the dissecting out of the tumour, after making a longitudinal incision down upon it, and the leaving of flaps.—(See his work, " De Rectâ

In England, during the first half of the last century, in extirpation of the mamma, the ligature was, as on the continent, generally looked upon as an alternative and occasional measure, and not as the settled and established means of arresting the hæmorrhage. They commonly employed along with it—or instead of it—caustics and styptics. Thus Shaw, in his "Practice of Physic," published

Curandorum Vulnerum Ratione," Amsterdam, 1658, pp. 89, 90, *sqq.*) Sprengel erroneously describes him as not cutting out the tumour, but as tearing it out with the hand alone—as he subsequently represents Platner doing, with the view of the process of avulsion serving to prevent the hæmorrhage.—(See Sprengel, "Histoire de la Médecine," tom. viii. pp. 421, 451.)

[1] *Pallucci.*—See his "Nouvelles Remarques sur la Lithotomie, etc., et sur l'Amputation des Mammelles," Paris, 1750, pp. 300-304.

in 1745, states, that after the excision of the breast "the mouths of the larger vessels are to be stitched or tied up, or the hæmorrhage stopp'd with buttons of vitriol or the common styptics."[1] The first surgical author who, as far as I know, declares exclusively for the ligature, and for it alone, after excision of the mamma, is Mr. Sharp. In his "Treatise on the Operations of Surgery," published in 1739, in his chapter on "the amputation of the cancer'd and scirrhous breast," he speaks of no other method of stemming the attendant hæmorrhage except the ligature.[2]

A man of few words, but of unchallengeable honesty, the celebrated English surgeon William Cheselden—the master and teacher of Sharp—has published, in some notes which he wrote to Gataker's English translation of Le Dran's "Operations," a statement full of high and yet of humiliating interest in regard to the operation which we are considering—namely, the excision of the diseased mamma. Cheselden's note shows that the chief improvements which occurred in England in that operation, in the earlier half of the last century, were not wrought out by the orthodox members of the profession, but by a clerical amateur. This stranger to the profession introduced three leading improvements in the operation—namely (1.) Instead of slicing off the mass at once, he dissected out the tumour after making an elliptical incision down upon it—saving thus flaps of skin and subcutaneous tissue to cover the gash produced; (2.) He employed ligatures alone in staying the hæmorrhage; and (3.) He dressed the wound simply, and without the old incumbrances of ointments, balsams, pledgets, bandages, etc. Cheselden adds a diagram illustrative of this amateur's mode of operating. It is here copied in Fig. 23, where the left breast shows by a dotted line the elliptical form of the incision used, and the right breast represents the diseased mass dissected out, the pectoral muscle left bare, and the form of flaps that remained. "The way," says

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[1] *Shaw.*—See his "New Practice of Physic," 6th edit., vol. ii. p. 633.

[2] *Sharp.*—See his "Treatise on the Operations of Surgery," 3d edit., 1840, p. 131.

Cheselden, "of extirpating cancers in the manner here described, was introduced with us by a bold

Fig. 23.

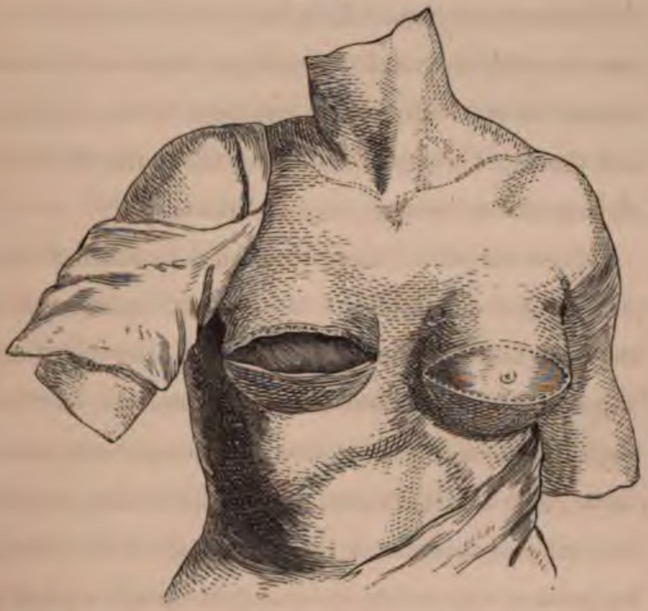

Fig. 23. The dotted line on the left breast shows the form of the incision. The right breast represents the wound left after the removal of the diseased mass (Cheselden).

and not very ignorant Clergyman. He was universally railed at by the profession, which greatly helped on his reputation; but the truth is, he extirpated with less loss of skin, took the tumours out more clearly, and then tyed up every vessel as he proceeded, and through ignorance, as they called it, dressed more simply than was the practice among surgeons—all which contributed to his success, which exceeded anything that had been known before. But his operations were tedious, and the more learned *following* the same method his reputation in a manner faded away."[1]

Since the time when Cheselden published the preceding account of the mode of extirpating the mamma, I am not aware that any alterations of importance have taken place in England, in the way of performing the operation, down to our own days. The configuration, length, direction, etc., of the primary incision or incisions, and of the flaps, has been proposed to be almost infinitely varied; and the mouths of the bleeding arteries, instead of being ligatured during the progress of the incision, are now almost always ligatured after the incision is completed. But these circumstances do not affect the principles of the operation, and of the subsequent treatment of the wound, as practised by the clerical operator referred to by Cheselden.

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[1] *Cheselden.*—See the "Operations in Surgery of Mons. Le Dran," translated by Thomas Gataker, 1749, p. 454.

The rapid retrospect which we have taken in the present and in the preceding chapter of the olden modes of amputating limbs and of removing the mamma, teach us two important lessons—*First*, The great difficulty and slowness with which the ligature of arteries was introduced into practice; and, *Secondly*, The equally great difficulty and slowness with which these operations were afterwards gradually modified so as to allow the chances of a greater and greater amount of primary union in the resulting wounds. But complete and entire adhesion by the first intention, of the wounds following amputation or excision of the mamma, was a result which—however skilfully and ably aimed at—could never be fully attained when ligatures were used to arrest the hæmorrhage, because union of the lips of the wounds, at the sites of the tracks of the ligatures at least, and at their tied extremities, was a matter of simple impossibility. All the other parts of the wounds might heal by primary union; these parts could not. But already we have seen, in Chapter VII., the possibility of the wounds, left both by amputations and by the excision of the mamma, completely and entirely healing where acupressure-needles were temporarily applied to close the vessels instead of ligatures. And if the present chapter were not already too long, I might cite various instances, in addition to Case VII., of the successful primary closure of other very large wounds left by extirpation of the mamma, where acupressure was used as the hæmostatic agent instead of deligation.

The whole history of the ligature in surgery powerfully and yet painfully teaches us how very hard and hateful a work it is for the professional mind to give up ideas and practices in which we have been long tutored and trained by education and experience. One "obstacle to the progress of surgery," as the old English surgeon Bromfeild observes, "has been a dull and lazy acquiescence in the established methods of operating, as if every deviation from the common way ought to be esteemed at best as an useless refinement upon what experience had taught us was sufficient for our ends;" and there are, he adds, "bigots in every profession, and many in surgery, who from habit, prejudice, and false reasoning, cannot fall in with any proposal which does not exactly coincide with their notions of things."[1]

Under the dread of giving up the red-hot cautery and cautery-knife for the silken ligature, some of the old surgeons waxed eloquent upon the supposed superior properties of their special instruments and methods. We have already found Hildanus talking admiringly and almost lovingly of the "egregiæ virtutes" of his horrific *Cauterium Cultellare* (see *ante*, p. 201), and other old authors speak with similar enthusiasm of their simple red-hot cauterizing irons. In the same spirit, in opposition to the introduction of acupressure, I have both read and heard of leading and eminent surgeons of our own day, stating that the ligature was "one of the grandest things in surgery." But inevitably the ligatures of arteries, in traversing—as foreign bodies—the cavities of wounds, and in remaining anchored in their depths and sides by small strangulated morsels of dead flesh, do hinder and hamper the process of healing by primary union. In all surgical operations in which they are used, the threads themselves are, as it were, archæological remnants of the former dressings that used to be applied to the interior of the stump, and the sloughs produced by them in the ends of the tied arteries are fragmentary emblems of the old sloughs made by the ancient cauterizing irons and caustics. Can it possibly be one of the "grandest things" in surgery to bury and implant in the depths of every wound which it inflicts as many small sloughs of dead decomposing arterial tissue as there are arteries tied—and expect primary union to follow? Surely English surgeons in the latter half of the nineteenth century ought to be able to boast of something better than a practice which thus bids utter defiance to all the fundamental principles of true English surgery.

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[1] *Bromfeild.*—See his "Chirurgical Observations and Cases," 1773, vol. i. pp. 4, 8.

CHAPTER XV.

SPECIAL ARGUMENTS AGAINST ACUPRESSURE.

"WHOSOEVER," sagaciously remarks Dr. Henry Marshall, "proposes an alteration of existing usages, will meet from some men with a sort of instinctive opposition, which is influenced by no process of reasoning, by no considerations of propriety or sound policy, which defends the existing system because it exists, and which would have equally defended its opposite if that had been the oldest."[1]

In accordance with this old and acknowledged principle of opposition, a variety of special objections have been urged against acupressure, in addition to those general objections to it which we have considered in a preceding chapter (see Chapter XII.)

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[1] *Marshall.*—See his Essay on the Abolition of Flogging, etc. in the Army, in his "Military Miscellany," p. 182.

Most of these objections, both general and special, might perhaps have been anticipated; for human thoughts and actions—being always fundamentally the same—are liable to be found repeating themselves in cycles; and the arguments against the proposed innovation of acupressure might have no doubt been discovered in the main, in the arguments long ago adduced against other analogous innovations. Indeed, we shall presently have occasion to observe, that almost all the leading arguments and objections which in olden times were urged against the introduction of the ligature, and in favour of the perpetuation of the heated iron, have been reproduced—perhaps unwittingly—against the introduction of acupressure, and for the perpetuation of the ligature. Names and men, and times and things, change, but the spirit of opposition ever continues wonderfully similar.

In the present chapter it will be necessary for us to consider a variety of special objections urged against acupressure, at some detail—however tedious and disagreeable the process may be; and in doing so, perhaps we may find that most of these so-called objections turn out as arguments in favour of acupressure rather than as arguments against it.

FIRST OBJECTION.—*Compression of the Attendant Veins and Nerves.*

"In acupressure," observed Professor Miller, "it appeared to him impossible to limit the needle to the bleeding point, so as to avoid including along with it the vein, and probably also the nerve. But it was well known," he continued, "that veins were extremely intolerant of pressure, and could not be subjected to it without the most hazardous consequences."[1]

The simple and direct answer to this objection, as a whole, consists in the fact, that acupressure has now been used in a large number of amputations and other operations, without any such evil consequences as those suggested by Professor Miller having ever been produced.

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[1] *Miller.*—See the "Edinburgh Medical Journal," December 1860, p. 568.

But let us take the objection in its two individual parts, as referring, *first*, to veins; and *secondly*, to nerves.

(1.) *Compression of Veins.*—Even *à priori* one would scarcely, I think, expect that the mere compression of the tube of a vein, for twenty, forty, or sixty hours, would be liable to excite deleterious results. In his very able work on surgery, Professor Miller, following the practice of Davat and Velpeau, recommends for the cure of varix, that a series of needles and threads, in the form of twisted sutures, should be placed around the dilated vein, so as to compress and obstruct its canal—not for some hours, as in acupressure, but for "some days." And he speaks of this as a "simpler and safer mode of treatment" than any other.[1] But if a diseased vein can stand such prolonged and strong pressure with comparative impunity, surely a sound vein may do so still more safely when the pressure is both much less in degree and much shorter in duration. After venesection, and wherever, in fact, there is venous hæmorrhage, we compress the sides of the vein together with a pad or otherwise—and, I think, usually without dreaming that any evil consequences are apt to follow the temporary obliteration of the venous tube by compression.

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[1] *Miller.*—See his "System of Surgery," p. 443.

But, further, I am inclined to hold that the closure of the vein along with the artery is, perhaps, a gain from acupressure, instead of an objection to it. Dr. Watson, lecturer on surgery in Edinburgh, has advanced the opinion, that one great cause of the non-union of amputation-wounds by primary adhesion was the circumstance, that when the wounds were closed, "oozing ensuing afterwards, the cut surfaces were kept apart by a coagulum, which, acting like a foreign body, induced suppuration."[1] Surely any such deleterious coagulum of blood is much more likely to be mainly, if not entirely, venous than arteria. in its origin; for every careful and conscientious surgeon takes due pains to close all the arterial orifices that are bleeding upon the surface of his wounds. He diligently ties these arterial orifices, though he usually avoids tying any venous orifices. Sometimes, however, though not very often, the veins in a stump-wound, as described by Chelius, Velpeau, Fergusson, Skey, and others, do bleed so profusely as to require to have their orifices occluded. If these orifices are tied with a ligature, the tissues of the vein are lacerated; and such physical injury may be apt occasionally to terminate in phlebitis. If, on the contrary, these venous orifices are closed by acupressure, they escape any direct physical injury to their tissues; and further, perhaps it may yet be found that the closure of the venous orifices in stumps, where acupressure is used, is a prophylactic measure of great importance in this respect—that hereby we prevent, to a certain extent, the introduction or absorption, by these gaping venous orifices, of deleterious and ichorous fluids existing upon the surface of the wound itself.

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[1] *Watson.*—See the "Edinburgh Medical Journal," December 1860, p. 569.

(2.) *Compression of Nerves.*—Mr. Miller's other idea with regard to the supposed deleterious effects of compression of the attendant nerves in acupressure is, I believe, equally groundless and hypothetical with that regarding the supposed injurious compression of veins. Patients whose wounds are acupressed have certainly not more pain than those patients in whom the ligature is used. I have seen the central artery of the sciatic nerve, and, consequently, the mass of the nerve itself, compressed by an acupressure-needle without any bad effects; and here the nerve compressed was the largest that can be met with in surgical wounds. The case in which this occurred was in the practice of Dr. Handyside, and was, in various other respects, interesting in reference to our subject.

CASE XI.—*Amputation of the Thigh at its Upper Fourth—Compression of Sciatic Nerve by Acupressure-Needle.*—The patient was a strumous man, aged forty-one, emaciated and debilitated to the last degree, and labouring under high irritative fever, in consequence of an extensive ulcer from a burn. The ulcer was of several years' duration, and involved the right thigh, knee, and leg. Dr. Handyside amputated the thigh at its upper fourth. The vessels which bled were acupressed with short needles. As the wound was about to be closed, a projecting portion of the sciatic nerve was clipped off, and its central artery began to bleed freely. To avoid the removal of the stitches which had been already introduced, a needle, five inches long, was brought down between the sciatic nerve and the os femoris, through the skin of the region of the hip, and made to emerge between five and six inches from its point of entrance. The effect of this acupressure was instantaneously seen in the bleeding being arrested. This long needle was removed from under the sciatic nerve twenty-five hours after the operation. The stump yielded a discharge of pus not great in quantity. Two months after the operation, both the stump and the entire body of the patient had become stout; and his pulse, which, long before the operation, had been extremely rapid and intermittent, was now seventy-two, and regular. On the night of the operation the patient had severe pain in the back, —an effect produced more probably by cold, wetting, and exposure on the operating table, than by the acupressure of the sciatic nerve; for the withdrawal of the needle had no effect in lessening the pain; it increased subsequently, and was relieved, at his own suggestion, by the application of a strengthening plaster—a remedy which he had used successfully in previous similar attacks.

In the observations of Professor Miller, from which I have cited his objection regarding the deleterious compression of the veins by acupressure, he argues that, in surgery, innovations are not necessarily improvements. Shortly after arterial deligation was suggested, M. Gourmelen, Professor of Surgery in Paris, used the same argument, in nearly the same words, against Paré's "*new* way to tye the vessells," and its "farre greater perills." He maintained that the drawing out of the vessel for deligation would "bring no lesse paine than the cautering irons doe;" and he adduced Professor Miller's objection regarding veins and nerves—"for if the needle, says M. Gourmelen, "shall pricke any nervous part, yea, the nerve itselfe, when he shall by this new and unaccustomed way, absurdly constraine the veine by binding it, there must necessarily follow a new inflammation; from an inflammation a convulsion; from a convulsion death."[1] No one, I fear, has any great respect now for these arguments against deligation, and in favour of the "burning and ustion of vessells," "much praised and commended, and always approved by the Ancients." Perhaps the same argument, as applied against acupressure, is destined ere long to meet the same fate.

Let me here add, that the correlative argument of greater suffering being probably attendant upon acupressure than upon deligation, was, long after the age of Gourmelen, used against the ligature as compared with actual cauterization. Strange as it may seem and sound to us now, the ligature was viewed by many surgeons as more painful than the red-hot cautery. The binding or ligature of the vessels for the bleeding of wounds is—avows Cooke, in his "Marrow of Chirurgery"—"very painful and much unused."[1] "It is certain," observes M. Louis, "that the ligature is a painful operation" (une opération douloureuse").[2] And in his "Critical Enquiry into the Present State of Surgery in England," Mr. Sharp tells us, in the middle of the last century, that some operators still employed the ligature sparingly, from their "horrid apprehension of compressing the nerves."[3] When prejudice thus warped the professional mind so strongly against deligation, on the score of pain from compression of the nerves, as compared with the burning of the cautery, it is no wonder that a similar and equally groundless objection should be conjured up against the effect of acupressure as compared with the ligature.

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[1] *Gourmelen.*—See the translation of Professor Gourmelen's Objections, in the English edition of Paré's works, pp. 1133, 1134.

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[1] *Cooke.*—See his "Mellificium Chirurgiæ," 1693, p. 105.

[2] *Louis.*—See the "Memoires de l'Académie Royale de Chirurgie," tom. ii. p. 394.

[3] *Sharp.*—See his "Critical Enquiry," 1761, p. 310. Some surgeons formerly argued for the use of the tenaculum instead of the artery forceps, on the ground that the tenaculum was less likely to include the nerve, and hence likely to avoid pain from the ligature. "The tenaculum," says Mr. Clare, "is now much used, and has the advantage of the needle and ligature, which give exquisite pain by including the nerve; no wonder, therefore, that the tenaculum is coming more into practice."—(See Clare's "Essay on the Cure of Abscesses by Caustic, and on the treatment of Wounds and Ulcers," 1779, p. 45.)

SECOND OBJECTION.—*Acupressure only adapted for Occlusion of Small Arteries.*

Professor Erichsen, in his admirable treatise on "The Science and Art of Surgery," while admitting that acupressure is, in the case of small arteries, "unquestionably a safe as well as a convenient and easy method of suppressing bleeding," still maintains that "for arteries of large size, as the femoral, it yet remains to be shown that acupressure can be depended upon as a mode of restraining hæmorrhage equally safe with the ligature."[1] Already, however, acupressure has been repeatedly employed in stopping hæmorrhage from the largest vessels ever opened in wounds, and that as readily, and as successfully, as from the smallest bleeding arteries. It has been used repeatedly in all the larger amputations. I know of upwards of a dozen cases of amputation of the thigh in which the femoral and all the other arteries of the stump were simply, easily, and successfully secured by acupressure.

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[1] *Erichsen.*—See his "Science and Art of Surgery," 3d edit., p. 154.

THIRD OBJECTION.—*Acupressure applicable to Amputation-Wounds only.*

Lately Dr. Neudörfer of Prague has stated, that acupressure is a process of arresting hæmorrhage, which "can be employed in amputation-wounds only."[1] This statement, in all probability, is the result of some imperfect notice of acupressure which Dr. Neudörfer may have seen. At all events, it is a misapprehension of the method; for, besides having been now employed in many amputation-wounds, it has been used successfully in numerous instances of excision of the mamma, after the extirpation of other tumours, and wherever, in fact, in surgical wounds, it was the object of the operator to strive for their primary adhesion, or to close a bleeding arterial orifice.

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[1] *Neudörfer.*—See his "Handbuch der Kriegschirurgie," 1864, p. 213.

FOURTH OBJECTION.—*Great Number of Needles sometimes required.*

I have heard it urged that in some wounds, as amputation-wounds, and especially where the operation has been performed for a chronic pathological disease, the number of bleeding arterial orifices is sometimes too great to allow of acupressure being employed. Usually, in the largest amputations, the number of arterial orifices that require to be secured does not exceed half a dozen, and they are often fewer; but Cloquet, Erichsen, Ballingall, and others have described some exceptional cases where twenty or more ligatures have been found necessary after amputation:[1] that is, twenty or more points in which the surgeon voluntarily set up a process of local strangulation and sphacelation, of ulceration and suppuration in the stump; with twenty ligature or seton threads tied to these points! What chances are there of such a wound going on prosperously and successfully? If twenty or more needles were ever requisite, their use, at all events, would be followed by no such unfortunate local lesions as the ligatures inevitably produce. But, in such cases, acupressure further presents advantages that can scarcely be claimed for the ligature, for one needle is occasionally capable of stanching the flow of blood from two or more separate orifices. In proof of this, let me adduce a case of amputation of the thigh, performed by an eminent surgeon, Mr. Crompton of Birmingham.

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[1] *Unusual number of bleeding vessels in some cases of amputation.*—See various instances mentioned by Cloquet in the "Dictionnaire de Médecine ou Répertoire Général des Sciences Médicales," 2me edit., tom. ii. p. 436; Erichsen, "Science and Art of Surgery," 3d edit., p. 19; Sir George Ballingall, "Outlines of Military Surgery," 4th edit. "In one case," says Sir George, "I have seen nine vessels secured upon the table and eleven afterwards; in another we had eight or nine vessels secured before the patient left the operating table, and the same number within an hour afterwards in consequence of hæmorrhage from the stump. In another recent case, I saw sixteen vessels secured

CASE XII.—*Amputation of the Thigh for Scrofulous Disease—Needles removed in Fifty-two Hours—One of them Compressing Two Ves-*

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before the patient left the table, and five afterwards in the course of the same evening" (p. 402).

sels.—On February 29, 1860, Mr. D. Crompton amputated a young man's thigh for strumous disease in the femur, and consequent degeneration of the cartilages of the knee-joint. Two accupressure-needles sufficed to arrest the bleeding, one of them pressing on the femoral artery, and the other pressing upon two small muscular branches. After fifty-two hours the needles were all withdrawn. On March 29, or exactly four weeks after the operation, Mr. Crompton sent me a cast of the stump, with a note, stating that the young man was then quite well. In this case, no rollers, nor plasters, nor indeed dressings of any kind, were applied to the stump.[1]

A case of another form of amputation—namely, that of the arm—has been published by Mr. Dix of Hull, in which that gentleman secured five bleeding arteries by the employment of three acupressure-needles.

CASE XIII.—*Amputation of the Arm—Three Needles Occluding Five Vessels.*—The operation was necessary to save the patient's life, on account of severe and old-standing disease of the elbow-joint, etc. The patient was himself a very unhealthy, ill-conditioned subject, and prone to suppuration. Eight vessels were secured by the acupressure-needles. One of the needles was made to compress two vessels in the posterior flap, at some distance apart. The two needles placed in the anterior flap closed three arteries. The last of the needles was not withdrawn till five days after the operation. During the healing of the wound the whole amount of purulent discharge did not exceed two drachms, and this came exclusively from the tracks of the retained needles. There never was any from the surfaces of the flaps.

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[1] *Crompton.*—See the "Edinburgh Medical Journal," May 1860, p. 1047.

In reference to the objection we are considering, let me here add, that possibly the day may come when one acupressure-needle may perform the function of many ligature-threads. For, possibly, in some amputations an acupressure-needle or needles will yet be passed—immediately before the operation—half an inch, or an inch or more, above the proposed line of the wound, so as

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[1] *Dix.*—See the "Medical Times and Gazette," June 2 1860, p. 547.

to shut the principal artery or arteries of the limb, and render the whole operation comparatively bloodless. If so, these needles would serve, at one and the same time, the double uses for which the tourniquet and arterial ligatures are now employed, and would, besides, leave the wound free from the presence of any hæmostatic foreign body whatever. In weak subjects, incapable of standing any loss of blood, "a suggestion has been made," says M. Velpeau, "to place a ligature upon the principal artery of the limb before commencing the incision of the soft parts. M. Blandin," he adds, "gives an example of this practice, which is still followed at the Hospital of Beaujon by M. Marjolin."[1] The deligation of the principal artery of a limb, as of the femoral, is an operation which itself is attended with considerable risk to life; but the acupressure of it is probably, on the contrary, alike comparatively free from difficulty and danger.

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[1] *Closing the arterial trunks before amputation.* — See Velpeau's "Médecine Opératoire," tom. i. p. 345.

FIFTH OBJECTION.—*Death of the End of the Bone.*

As an objection not so much against acupressure as against the probability of union by the first intention following its use in amputation, Mr. Spence — one of the most careful and most successful of living surgeons—has argued that the "difference of textures in the stump was the principal cause of the suppuration; the end of the bone had to be rounded off; in this process portions died, and it often happened that, long after the ligatures had come away, discharge was kept up by the presence of little bits of dead bone."[1]

Now, that the end of the amputated bone does not offer anything like an insuperable obstacle to the primary union of stump-wounds, is proved by the admitted fact, that such wounds, when ligatures are employed, do sometimes, however rarely, heal at all points except where the ligatures are found. I have already brought forward in this essay a variety of cases of amputation-wounds, treated not by ligature but by acupressure, where the wounds *did* heal entirely by primary union. I have adduced, for instance, cases of amputation of the thigh, of the leg, of the arm, and of the forearm, in which the vessels were acupressed, and entire union by the first intention followed. These are instances of the four largest sets of bones divided in amputation, and in none could have "portions died" of the extremities of these bones; for, if that had happened, primary union would have been utterly impossible.

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[1] *Spence.*—"Edinburgh Medical Journal," Jan. 1864, p. 666.

Mr. Spence overrates greatly, I believe, the frequency of necrosis. "Exfoliation from the bone, once an invariable attendant on amputation, is," observes Mr. Lister, "now rarely met with—except as the result of mismanagement."[1] But perhaps there are few conceivable conditions more likely to lead to the death of portions of a divided bone, than having in their neighbourhood, or in contact with their surface, for a succession of days—as happens under deligation—irritating foreign bodies, such as the ligature-threads, and portions of strangulated and sloughing tissue. Bone is a tissue relatively of so feeble a type of organisation, that it cannot withstand the same amount of irritation as the more soft and vitalised textures. Hence, "in a majority," says Dr. Wilks, "of our cases of pyæmia the bone was involved, being, in the case of stumps, necrosed, and involved in a suppurating or sloughing process."[1] Surely, to save the bone, therefore, we should carefully avoid forming sloughs and suppuration in the wound. We do form them by using ligatures. We so far avoid forming them by using acupressure. Besides, according to Cruveilhier[2] and other pathologists, pus or sanies in contact with the divided bones is specially dangerous, on account of the liability of the osseous veins (which do not readily close) easily absorbing such morbific materials. General pyæmia, in short, often, in the opinion of these pathologists, originates in pus formed in, or entering into, the unclosed osseous veins exposed in the cut ends of the amputated bones.

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[1] *Exfoliation from the bone.*—See Mr. Lister's article on Amputation in Holmes' "System of Surgery," vol. iii. p. 70. According to M. Velpeau, "exfoliation of the bones, which was formerly regarded as inevitable at the end of every amputation, is now-a-days admitted to be an accidental result."—(See his "Médecine Opératoire," tom. i. p. 351.)

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[1] *Wilks.*—See "Guy's Hospital Reports," 1861, p. 121.

[2] *Cruveilhier.*—See the "Dictionnaire de Médecine et de Chirurgie Pratiques," tom. xii. p. 674.

With the exception of bone, the structures entering into the composition of the walls of a vesico-vaginal fistula—which usually, when operated upon, easily closes by primary union—are less bulky, but in regard to the mere number of their component tissues, are as complex as those of a stump, for they include the muscular walls of the vagina, the muscular walls of the bladder, two mucous surfaces—the vaginal and cystic; arteries, veins, absorbents, and nerves, and quantities of connective tissue.

Professor Fergusson of London—perhaps the most eminent operator of our day—has suggested what may be regarded as two other arguments against acupressure.

Sixth Objection.—*Tracks of Ligature useful as Vents for Pus.*

The high surgical authority to whom I refer seems inclined to hold that deligation was preferable and useful, because "the tracks of the ligatures acted as vents for the discharge of pus."[1]

On the contrary, I incline to believe that one great and undoubted source of the suppurations in the interior of wounds is the very presence of the ligatures and of the sloughs and irritation which they produce; and if primary adhesion were far more directly and distinctly aimed at, the formation of any considerable amount of pus would be a far more rare occurrence. In short, it is better, I am inclined to argue, to avoid having foreign bodies, as ligatures, left in the wound, and capable of producing pus, in order, as far as possible, to avoid the formation of pus, rather than lead the pus off by these foreign bodies after it is once formed. By their presence they tend to create the pus as well as evacuate it; but in surgery, as in other practical sciences, the principle of prevention is recognised as infinitely superior to the principle of cure.

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[1] *Fergusson.*—See the "Lancet," Jan. 24, 1863, p. 95.

SEVENTH OBJECTION.—*Acupressure might Heal Wounds too rapidly.*

Mr. Fergusson uses another, and, as I look upon it, a still stranger objection. He fancies the advantages of union by the first intention overrated. "Suppose"—to use his own words—"the stump did heal by first intention, it could not be used for weeks—for months—as it was, in great measure, new material, which would not bear pressure. In fact, the ligatures were of advantage in this way, that they prevented the patient using his limb too soon."[1]

Now, if the mere speed with which a wound was completely healed were any objection to the method by which that speed was accomplished, it would be a strange paradox in professional ethics. It would be an argument, at all events, that no patient could appreciate or approve of; for it would be difficult, I opine, to persuade him that his wounds should heal slowly under a chronic application of local disturbances, dressings, and discharges, rather than heal swiftly and kindly without any long continuation of pain, or vexation, or trouble whatever. The cure of a surgical wound, as much as the infliction of it, ought always surely to be accomplished, as Celsus writes it, "*tuto*;" but also as surely, wherever it is practicable, "*cito et jucundè*."

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[1] *Fergusson*—See the "Lancet" for January 24, 1863, p. 694.

Some time ago Mr. Syme stated to the Medico-Chirurgical Society of London, that he considered acupressure to be "objectionable on three grounds." Let us consider his three grounds.

EIGHTH OBJECTION.—*The Ligature not Hurtful but Useful in the Healing of Wounds.*

Mr. Syme's first ground of objection is triple in reality in its character, or includes three different items—

(1.) "The ligature," according to Mr Syme, "did not deserve the charges which had been brought against it,"[1] in regard to its alleged effects upon the artery and surrounding tissues. On this point I have already, in Chapter IV., cited a long array of our very highest surgical authorities proving that, in deligation, the tied artery at the strangulated point does inevitably die, and become a mortified piece of tissue. On the present occasion I shall content myself by citing against this argument of Mr. Syme's one authority more—namely, the high authority of Mr. Syme himself—as to the state of the end of a ligatured vessel; for, as he correctly states, the ligature "at once *deprives* the part embraced within its noose *of vitality*."[1] This devitalised, dead condition, whether we term it a state of mortification, as Mr. Syme seems to wish, or a state of gangrene—to use the meaning attached by Mr. Travers and other leading surgical pathologists to this last term—is doubtlessly the general and inevitable effect of every ligature applied to the extremity of a cut artery.[2]

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[1] *Syme*—See the "Lancet" for May 5, 1860, p. 445.

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[1] *Syme.*—See the "Lancet" for May 5, 1860, p. 445.

[2] *Travers on the term Gangrene.*—See his "Physiology of Inflammation." "I do not employ," says he, "the term 'mortification,' because it is not technically explicit, and has been vaguely and indiscriminately used. Nor shall I use the term 'sphacelus,' because Gangrene is a sufficient synonym, if the term gangrenous inflammation be accepted, which presents the stages of recoverable and irrecoverable, threatened and devitalised texture. A

(2.) "It had been further said," argued Mr. Syme, "that the ligature caused injurious irritation subversive of the uniting process." Most certainly it is liable to do so, and often does so—especially to the parts more immediately near it. For any *excess* of irritation or inflammation subverts adhesion; and I have already shown (*ante*, p. 24, etc.), on the authority of John Hunter, Cooper, Lawrence, etc., that the bodies of the ligatures do excite suppuration by their presence; whilst their tied extremities also create small gangrenes and sloughs in the sides and depths of the wound. A ligature in its track is confessedly

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gangrened part is never restored" (p. 208). See also South's translation of Chelius, vol. i. p. 53; and Paget's "Lectures on Surgical Pathology" (1863), p. 338. "On the Continent," says Sir Robert Carsewell, "the term gangrene is employed to signify" "that state which has been induced in a part of the body by the complete and permanent extinction of its vital properties."—(See his article on Mortification, in the "Cyclopædia of Practical Medicine," vol. iii. p. 116. See also Gross's "System of Surgery," Philadelphia, 1862, vol. i. p. 168.) Speaking of the state of an artery deprived of vitality, when placed between two contiguous ligatures, Mr. John Bell remarks, that the ligatured portion of vessel "falls into gangrene."—(See his "Principles of Surgery," vol. i. p. 219, etc. etc.

nought but a small or miniature irritating seton. Would Mr. Syme, or would any surgeon, have the hardihood to propose keeping setons, however small, between the lips of wounds, for the purpose of *producing* adhesion? And surely it is strange to argue that their mechanical presence, and the chemical irritation which they are apt to produce in such a position, do not constitute very evident causes of the non-occurrence of adhesion along the course of their tracks and in their immediate vicinity. The neighbouring surfaces have newly-formed organisable materials effused upon them; and, as Mr. Lawrence correctly tells us, "all newly-formed parts are weaker in vitality than the original structures, and ulcerate more easily."[2] The

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[1] *Ligatures are small setons.*—See Note 1, p. 24, *ante.*

[2] *Weak resisting power of wounds.*—See Mr. Lawrence's "Lectures on Surgery," p. 181. John Hunter, when treating, with his own profound sagacity, of inflammation attacking new-formed parts or substances, had long before observed, "We shall find these parts more liable to dissolve than the natural parts are, having weaker powers of action. In proportion, therefore, to the quantity of new matter, is the part weaker; and these parts go through their diseases much quicker than original ones. When new-formed parts are under the necessity of inflam-

"*principal* obstacle," the same surgeon elsewhere observes, to the "speedy union" of wounds is the presence in them of the body of the ligature;[1] and hence his well-known proposition to cut the ligatures short.

But when not reasoning against acupressure, Mr. Syme himself is ready, by his strong and practical evidence, to confute these observations of his own regarding the non-irritating effects of the ligature-threads in the healing of wounds. I have already (p. 26) cited him as stating that the union of wounds by the first intention is liable to be frustrated instead of being promoted by the induction of inflammation. He himself, in his "Principles of Surgery," further correctly states, that besides inflammation being "preventive of primary union," the interposition of any foreign substance is "no less adverse to the process;" and in another part

mation, a very slight cause is sufficient; and the inflammation goes on more rapidly than in original ones; and it requires more attention and care to stop its progress."—(See his "Works," by Palmer, vol. i. p. 576.)

[1] *Lawrence.*—See the Transactions of the Medico-Chirurgical Society of London, vol. vi. p. 172.

of his work he places ligatures in the category of such foreign substances, telling us that "in wounds of the lips and cheeks, in which union by the first intention is very desirable," their use should be avoided, for "the coronary arteries, and other branches of the facial, cannot be tied without leaving threads *apt to disturb* the adhesive process."[1]

(3.) Mr. Syme further alleges that, "so far from regarding ligatures as hurtful, he had long looked upon them as useful, by maintaining a connection between the bottom and surface of wounds, so as to prevent that accumulation of blood in the cavity which is so apt to happen, and substitute an abscess for primary union."[2] Now, in regard to such a novel and singular reason for using and preferring ligatures, I must beg leave to remark, that if "accumulations of blood" in the cavities of wounds are so frequent as is represented in the sentence which I have quoted, there must assuredly be something very wrong either, *first*, in the ligature itself as a hæmostatic agent, to allow of any such common secondary escapes and collections of blood between the lips of wounds; or else, *secondly*, the wounds must have been closed too soon and before all the primary oozing had properly ceased. In the former case the ligature is used to repair its own hæmostatic deficiencies; in the latter, it is used to repair the unnecessary haste of the surgeon. And certainly a very imperfect reparative means it must prove in any way, if at all. Is it not far more likely, by its presence and by its mere mechanical irritation upon the vascular granular surface of the wound, to produce this internal oozing of blood—to create it rather than cure it? For it is difficult to see what curative effect it can possibly exert. If a systematic drain were really required from the depths and cavities of wounds, an actual small drainage-tube of the unirritating caoutchouc form, used so successfully in abscesses, etc., by M. Chassaignac, would surely be preferable to irritating, deleterious ligature-threads. But no surgeon has ever, as far as I know, ventured to propose to place such drainage-tubes for "accumulation of blood" between the lips of wounds; for the simple reason, I suppose, that no such provision is really required. The "accumulation" is a logical rather than an actual fact, and is advanced, perhaps, rather because there is a want of other or better arguments against acupressure, than because the thing itself is very apt to happen. Some large wounds, particularly if shut up too early, are liable, as we have seen in a preceding chapter (p. 106), to distil, from their surface, for a time, a coloured serum, but not "blood." Such reddish serum will always find free enough vent by the tracks of the acupressure needles and wires; and the formation and discharge of it are usually finished long before these needles or wires require to be withdrawn.

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[1] *Syme.*—See his "Principles of Surgery," pp. 40, 100.

[2] *Ligatures useful.*—See "Lancet," May 5, 1860, p. 446.

Some of the olden surgeons, in contesting and battling for the alleged superiority of the cautery over the ligature, anxiously maintained that a wound treated with cauterization was in a better and safer condition than a wound where the arteries were treated with deligation. For the limb, argues Fallopius, is dried, evacuated, and strengthened, by the charring of its surface with the red-hot cautery (" exiccetur, evacuetur, et corroboretur").[1] The burning cautery, when applied to raw surfaces, is, avers Maggi, " attended with little pain (*parvo dolore*), it drains off the malignity of the part, and gives strength to it."[2] " The cauter, or actuall fire," gravely reasons the famous old Glasgow surgeon, Peter Lowe, " draweth into it the virulency and malignitie of the humor which is in that part, and in that point it is more sure and better than knitting [or the ligature];" and the cautery " being made red hote," hath, he adds, when applied to the wound, " the vertue to drie and corroborate the same."[3]

The advantageous and profitable properties which were thus, in the olden times of surgery, claimed in the treatment of wounds for the hot cautery over the silken ligature, are evidently similar in character to those which Mr. Syme claims under similar circumstances for deligation as compared with acupressure. For these ligatures do not, in his opinion, cause injurious irritation, subversive of the uniting process; they are not hurtful but, on the contrary, useful in a wound; and they tend to promote and strengthen its healing by keeping it dry and drained of that accumulation of blood in the cavity of the wound which is so apt to happen, and substitute an abscess for primary union. They "drie and corroborate the same."

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[1] *Fallopius.*—See his " Opera Omnia," Frankfort, 1606, tom. i. p. 543.

[2] *Maggius.*—See his treatise " De Vulnerum, etc., Curatione," in Gessner's " Scriptores Veteres de Chirurgiâ," p. 267.

[3] *Lowe.*—See " A Discourse of the whole Art of Chirurgerie, compiled by Peter Lowe, Scottishman," and dedicated to " all such well experimented men in this Kingdome who are licenced to professe the Divine art of Chyrurgerie," 1634, p. 93.

How very different in philosophic spirit and wisdom are those views of Mr. Syme regarding the supposed beneficial effect of ligatures on the cure of wounds, from the observations made forty years ago upon the same subject by the distinguished French surgeon M. Roux! In the account which he published of his professional visit to this country in 1814, when treating of the means of promoting union by the first intention, M. Roux makes the following remarks :—"The ligatures are extraneous bodies, which, as long as they remain in the wound, irritate it, determine and keep up suppuration. There is certainly no doubt but that their presence is the principal obstacle to an adhesion without any suppuration, in those cases where the immediate union of a wound of greater or less extent is attempted ; and," M. Roux adds,—as if in anticipation of some such method as acupressure,—"if there were any means by which a wound that was to be united by the first intention should not be traversed by ligatures, the success of that immediate union would be still more certain."[1]

Mr. Syme, however, has, as I have stated, two other objections to acupressure.

NINTH OBJECTION.—*Torsion, a sufficient Substitute for Ligature.*

"But," again Mr. Syme argues, "if the ligature were objectionable, its place might be supplied by torsion."[2] In adducing this so-called ground of objection, he seems to have for the moment utterly forgotten that the observations of Manec, Chelius,[1] and others, have long ago fully demonstrated it as an established principle in surgery, that when torsion is applied to a large artery, the effect of the twisting and physical laceration of the coats of the artery is generally such, that the suppuration and death of some part of the contorted and torn arterial tissues are almost as certain to occur as after ligature. As Professor Miller, when treating of the effects of torsion, tersely and truly remarks—"The twisted portion of the vessel *must slough* and separate; the noose of a ligature is not more truly, or to a greater extent, a foreign body."[1]

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[1] *Roux.*—See his "Narrative of a Journey to London," English edit., p. 119.

[2] *Syme.*—"Lancet," May 5, 1860, p. 446.

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[1] *Manec and Chelius on the effects of torsion of the arteries.*—"In consequence of the bruising and trituration which torsion occasions in the arterial parietes, some portions of its component membranes are," observes Manec, "destroyed and *deprived of vitality.* These become a cause of inflammation, which, in addition to the longer and more painful manipulations of the torsion than of the ligature, terminate in producing a suppuration which is equally as great and lasting as that which can be caused by the application of a ligature."—(See Manec on the "Ligature of Arteries," translated by Garlick and Copperthwaite, pp. 97 and 110.) [Let me here correct an inadvertence committed in a previous page (p. 156), where, quoting this English translation, I have referred a sentence to Manec which properly belongs to Scarpa.—See Scarpa's work on Aneurism, translated by Wishart, p. 277.] "By the tearing," says Chelius, "and bruising of the arterial coats in torsion, separate fragments of the coats *die off* and suppurate."—(See Chelius' "System of Surgery," by South, vol. i. p. 310.) See also Sanson's essay, "Des Hémorragies Traumatiques," p. 161; Erichsen's "Science and Art of Surgery," 3d edit., p. 152; etc. etc.

TENTH OBJECTION.—*Acupressure only very limited in its Action.*

"He was persuaded," added Mr. Syme, "that the field for using the needle process would be found of the most limited extent, since it could only be adopted in cases where the vessel lay in the integuments or textures adhering to them."[2] This last objection of Mr. Syme merely proves that, at the time of making it, he simply and entirely misunderstood the whole subject. Acupressure has been successfully and repeatedly employed in the deepest and largest wounds, and in all forms of wounds. The great aim and object of acupressure is, it must always be remembered, twofold—namely, (1) to arrest surgical hæmorrhage, and (2) to promote the primary union of surgical wounds. I know of no wounds that can be possibly healed by primary union where acupressure cannot be applied with as great facility as the ligature, and certainly with far greater hopes of success. In wounds systematically intended from the first to be healed by suppuration and granulation, it is of much less moment whether the bleeding be originally staunched by acupressure or deligation. Perhaps there may be cases and circumstances in wounds where the ligature would answer and the needle not; but, if any, they must be few indeed. On the contrary, I know of several instances where acupressure has at once arrested the hæmorrhage after a fruitless trial of the forceps and ligature. In evidence of this important remark, I shall in the following chapter adduce several illustrative cases.

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[1] *Miller.*—See his "System of Surgery," p. 224.

[2] *Syme.*—"Lancet," May 5, 1860, p. 446.

CHAPTER XVI.

INSTANCES OF ACUPRESSURE SUCCEEDING WHERE THE LIGATURE HAD FAILED.

IN 1638, in his excellent "Treatise of the First Part of Chirurgerie, containing the methodical doctrine of wounds, delivered in Lectures in the Barber-Chirurgeons Hall," Dr. Alexander Read, "of the famous Citie London," denounced the "deligation of the vessell which sendeth forth blood" as in his judgment nothing but "a troublesome and dangerous toy, as he shall find who shall goe about to make triall of it."[1]

Earlier in the contest for the perpetuation of the cautery, and against the introduction of the ligature, another opponent of deligation, in another capital, the Professor of Surgery to the Faculty of

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[1] *Read.*—See his "Treatise," p. 12.

Medicine in Paris, M. Gourmelen, remarked, "If any man who has been subjected to this new butchery [of the ligature] has escaped in safety, that man ought to feel the profoundest gratitude, and give thanks for ever to Almighty God, through whose goodness he has been preserved from such cruelty and murder."[1]

In the seventeenth century, that patriarch of German surgery, as he has been termed, Hildanus, tells us that the use of the ligature was very limited. For even in amputations it could only, he avers, be employed in strong and plethoric patients, as so much blood was usually lost in attempting deligation, that it could not be tried without danger upon the delicate and emaciated subject ("in delicatulis verò et extenuatis absque periculo administrari non potest").[1] The reputed father of English surgery, Wiseman, had apparently still more contracted views of the applicability of the ligature in hæmorrhage, and it is doubtful whether he ever employed it. But, at all events, "in heat of fight," he adds, "it will be necessary to have your actuall cauterie always ready, for that will secure the bleeding arteries in a moment, and fortifie the part against future putrefaction."[2]

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[1] *Gourmelen.*—"Si quis novum hunc laniatum expertus incolumis evaserit, is Deo Optimo Maximo cujus beneficentia crudelitate ista et carnificina liberatus est, maximas gratias et habere et semper agere debet." See these words—the "Words of the Adversary" (as the rubric styles them), in a quotation from the original Latin work of Gourmelen, given in the English edition of Paré's "Workes," p. 1133; and Comperat's "Replique à une Apologie publiée sous le nom de M. Ambroise Paré," edition of 1647, p. 14; or Gourmelen's "Guide des Chirurgiens," p. 159. "O! what sweete words," observes Paré, "are heere from one who is sayd to be a wise and learned Doctor!"—(See his "Workes," p. 1134.)

Mr. Syme's ideas as to the field of applicability of acupressure seem to be equally limited, as we have seen in the last paragraph of the last chapter. He is aware, however, we believe, that it has proved apparently most salutary and successful in a case of amputation of the thigh which we have already recorded (see Case I., p. 71), and where the patient, when seeking advice in Edinburgh, immediately before the operation, was deemed, in the language we have cited from Hildanus, so "delicatulus et extenuatus," that amputation was refused.

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[1] *Fabricius Hildanus.*—See his "Opera Omnia," Frankfort-on-the-Maine, 1646, p. 814.

[2] *Wiseman.*—See his "Chirurgical Treatises," 1676, p. 453. "The ligature," says Professor Lister, "though known to Wiseman, seems not to have been adopted by him"—(Holmes' "System of Surgery," vol. iii. p. 54.)

But I have further to remark that there sometimes occur, in amputation and in other wounds, complications which render the application of the ligature to the bleeding vessels very difficult or indeed impossible. "It sometimes happens," observes Mr. Fergusson, "that the vessels cannot be readily got hold of with the forceps, or cannot be drawn out of their sheaths so as to allow a thread to be applied."[1] The retraction of the bleeding vessel is sometimes so great, and its orifice sunk so deeply, that it cannot be reached and laid hold of by the ordinary means. Diseased states of the tissues occasionally add to this difficulty. In some such cases acupressure has succeeded where deligation had previously failed. Of this circumstance let me adduce a few examples.

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[1] *Fergusson.*—See his "System of Practical Surgery," 4th edit., p. 37.

CASE XIV.—*Amputation of the Thigh—Difficulty of securing a deep Vessel—Acupressure.*—In one of the last cases of amputation of the thigh which I witnessed, Dr. M'Bain, Mr. Tait, and others were present. With his usual great rapidity and dexterity Mr. Edwards amputated the limb and secured by acupressure all the arteries exposed except one. This vessel bled most profusely whenever the compression of the femoral artery at the groin was relaxed. The bleeding orifice, which was retracted, appeared to be situated very deep in the angle formed by the flaps of the stump, and apparently at the upper end of the divided apex of a sinus that had run up alongside of the femur. It was, probably, a deep obturator branch. Mr. Edwards turned to me with the remark, that this was an example of a deep retracted bleeding vessel which only the ligature could secure. Of course, I made no remark, as the case was his and not mine. He tried to seize the bleeding orifice with the forceps and ligature over and over again, but without success. He then observed that it would be necessary to dissect up the flap somewhat to reach the bleeding artery, that its orifice might be properly laid hold of. I now ventured to ask him to try an acupressure-needle before doing so. The needle

—a long one, of the form Fig. 5 (p. 52)—was passed through the skin, and at once and effectually closed the vessel, being so introduced as to compress it against the bone (see *ante*, p. 56). The needles, six in number, were all removed in twenty-one hours—perhaps a date that would have proved too early for freeing such a vessel as the femoral from acupressure, had it not been that the patient was very young—between seven and eight—and the vessels correspondingly small. The boy's recovery was complete before the fourth week.

Surgeons know well that—especially in amputations in the upper part of the leg—the arteries sometimes retract so as to be difficult to catch and secure with the ligature. Both Mr. Guthrie[1] and Mr. Fergusson,[2] in describing amputation below the knee, speak of having seen cases where the divided tibial arteries retracted so much that the efforts to catch them for ligature ended in a kind of "despair." The following is an example of this complication in which acupressure at once succeeded:—

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[1] *Guthrie.*—"Commentaries on the Surgery of the War in Portugal," etc., 5th edit., p. 96.

[2] *Fergusson.*—"System of Practical Surgery," 4th edit., p. 492.

Case XV.—*Amputation below the Knee, with a retracted Artery.*—In a case of this kind, which occurred in 1862 in the practice of Dr. M'Kinlay of Paisley, several attempts were made to seize a bleeding tibial artery, both with forceps and with tenaculum, but without success. In order to reach the retracted artery, Dr. M'Kinlay then cut off a piece more of the bones, and again attempted deligation, but in vain. At last he procured a long "darning" needle, and immediately and successfully compressed the artery against the bone. Two other vessels were secured by ligature. The needle was withdrawn on the third day, and the patient made a good recovery; the wound healing, in great part, by first intention.

In another case of amputation below the knee, Dr. Clayton of Banff acupressed the posterior tibial artery in consequence of being unable to secure it by the ligature.

Case XVI.—*Amputation for Injury of the Leg—Acupressure.*—A distillery servant met with a severe injury of the leg. Erysipelas and extensive suppuration followed. Sixteen days subsequently, at a consultation, it was believed that amputation below the knee afforded him his only chance of escape. After the limb was removed, two arteries were secured by ligatures; but the orifice of the bleeding posterior tibial could never be seen, in consequence of the extent to which it had retracted, and several unsuccessful attempts were made by Dr. Clayton, and by a professional gentleman assisting him, to secure and tie the vessel. At last "I adopted," writes Dr. Clayton, "the mode of securing the vessel by acupressure with a common sewing-needle, threaded with the silk I was using. This was perfectly successful in a single moment." The needle was withdrawn in two days. One of the two ligatures did not come away for upwards of three weeks. The man made a very slow recovery.

Sometimes, as in the following example, the same difficulty has occurred in amputations performed lower down in the limb:—

Case XVII.—*Amputation at the Ankle.*—After removing the foot, Dr. Henderson of Leith secured by acupressure the two largest vessels that were opened. The ligature was applied to two small ones situated close to the cut extremities of the bones. A fifth vessel began to bleed freely when the stump was about to be closed. This vessel could not be secured by the ligature, which always slipped, owing to the dense nature of the tissue.

At last a small acupressure-needle was used, and easily secured it.[1]

For the following note of a case of retracted fibular artery, where the ligature failed repeatedly, I am indebted to Mr. Edwards:—

CASE XVIII.—*Amputation of Ankle—Retracted Fibular Artery.*—"The patient, a young man aged 22, had chronic disease in the ankle-joint. He was much exhausted by the malady. I removed his foot above the ankle. My chief reason for doing so was the exsanguine condition of the patient, and this prevented my attempting the then new method of acupressure. I *tied* several vessels, therefore; *but* the fibular artery had retracted, so that I could not seize it without further dissection. Professor Simpson, who was present, took a needle from his case, and secured the artery at once. This poor weak lad rapidly recovered; his stump healed in a great measure by first intention, except where my ligatures hung out; but to my amazement Dr. Simpson's needle healed *in*. Around it there was no suppuration, and when I withdrew it after two weeks, the eye was full of new material—granulation substance,

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[1] *Dr. Henderson's Case.*—See the "Edinburgh Medical Journal," February 1861, p. 698.

I suppose. The patient left Edinburgh in three weeks, and I saw him recently, well, with a good stump. I would venture to add, that although I could have tied his fibular artery, doing so would have put him in greater danger, while it would have put me to some trouble in the way of additional dissection, and prolonged the operation."

The cases which I have hitherto cited in this chapter all refer to difficulties which are occasionally met with in securing the arteries divided in amputation-wounds. But in various other forms of wound, also, acupressure has been found useful, where there was more or less difficulty in the deligation, or in the dissection required for the deligation of the bleeding arteries.

Few lesions, for instance, seem more simple, but at the same time have proved more perplexing and puzzling in practice, than divisions of the radial, ulnar, and palmar arteries—an accident that not unfrequently occurs from pieces of broken glass, cuts with knives, working-tools, etc. These lesions are occasionally attended with recurrent and distant attacks of great hæmorrhage; and the patient's limb, and even his life, may become endangered by the losses of blood. "Many cases," observes Mr. John Bell, "may be found in White, O'Halloran, Aitken, etc., where a person wounded in the radial artery has bled for three weeks or a month, till the blood was little better than a reddish serum." The rule of treatment with most surgeons in such cases is, I believe, to secure at once with ligature both ends of the divided artery. But sometimes one or other of its extremities is found retracted when searched for, so that it cannot be reached without more or less antecedent dissection—an operation that often cannot be very easily nor satisfactorily performed, by the country surgeon particularly, as he is often far away from proper assistants and proper instruments. And "though the operation of tying the radial or ulnar artery does not range in the catalogue of important operations, along with trepan and amputation, yet," observes a very high surgical authority, Mr. John Bell, "if I be not deceived, it is more difficult than either, and certainly more frequently required." In these lesions "there is," he remarks, "no safety in trusting to compression, sponges, or astringents, for you are, yourselves, never free from anxiety, nor your patients from danger." If the surgeon is not successful at once, "if he oppose the blood by slight compresses," continues Mr. Bell, "permitting it all the while to bleed within, the artery will shrink, the cellular substance will be crammed with blood, and the skin thickened also by inflammation. The seeking out of the artery among such a confusion of parts will be inconceivably difficult."[1]

The use of the dissecting-knife is often therefore required as a necessary preliminary step towards securing and tying the arterial extremities in such cases; and even when simple compresses are trusted to—as they are at first by some surgeons in wounds of the hands and feet—the wound, as pointed out by Mr. Syme, "should, if necessary, be dilated sufficiently," by the knife,

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[1] *John Bell.*—See his "Principles of Surgery," vol. i. pp. 183, 191, 451. For a further account of the dangers and fatal disasters occasionally arising from wrist-wounds, see pages 181 to 185 of that work.

"to admit the lint" of the compress to be "placed directly on the orifice of the artery."[1]

But, assuredly, it must be acknowledged as a sound principle in general medical practice—and even in surgery—that whenever we can accomplish our object without applying the knife to the living flesh of our patients, it is our duty to avoid it. And from what has been stated to me regarding more than one case of division of the arteries of the wrist[2] and palm, I believe that by acupressure, and without any skilled assistants, the general practitioner will usually be able to command these cases far more easily and surely than even by the knife and ligature; and that too, without leading to those large cicatrices and contractions of the wrist and palm which I have seen left as permanent results of the awkward and deep dissections made in anxious and painful pursuit of the bleeding arterial tubes or orifices. In such a case the acupressure-needle serves at once, as it were, the function of an internal compress upon the artery—whilst it shuts it up as effectually as a ligature. The following case is an instance of this application of acupressure:—

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[1] *Syme.*—See his "Principles of Surgery," p. 99.

[2] *Acupressure in arteries of the wrist, etc.*—Abroad the practice has been used in some cases. In a case of wound of the radial artery, M. Foucher employed an acupressure-needle, which sufficed to arrest the hæmorrhage without producing the slightest inconvenience. M. Foucher successfully used also the same means to stop the hæmorrhage in a case of wound of the temporal artery.—(See the "Bulletin de l'Académie Impériale de Médecine," tom. xxv. p 1087.)

CASE XIX.—*Wound of the Wrist, and Division of the Radial Artery.*—A young man of 16 received a wound from an axe in his left forearm immediately above the wrist, and had his radial artery completely divided. He was sent, with the wound and forearm very tightly bandaged, into the Carlisle Infirmary, where Dr. Hamilton[1] easily tied the distal end of the vessel, but failed to secure the cardiac orifice by ligature, owing to its great retraction. Instead, then, of extending the wound upwards with the knife, and exposing the artery so as to be able to place a thread round it, he had recourse to acupressure, passing a needle below the artery, and casting externally a wire-thread around it. This immediately produced the desired hæmostatic effect; and when the needle was withdrawn after thirty-four hours, the vessel proved to be quite occluded.

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[1] *Hamilton.*—See his "Reports" in the "Edinburgh Medical Journal," January 1864, p. 636.

In such instances as the preceding wrist-wound, and in other similar injuries, acupressure assuredly offers no small advantage over ligatures; and under such circumstances, it is certainly far simpler and safer to use acupressure, or the thread-compress as described in our next chapter, without any dissection at all, than deligation with its precedent and sometimes difficult dissection. Even on the dead body the great contrast between the deligation and the acupressure of these arteries is most striking.

Wounds of the arteries of the ankle and sole of the foot, are perhaps on the whole more easily managed than those of the wrist and palm. But, from the depth at which some of the larger arteries of the leg lie, they have generally proved to be less easily secured than the corresponding vessels of the forearm. In Case XVIII. we have seen acupressure restrain bleeding from a fibular artery, in a case of amputation, where it was found impossible to use the ligature. Sometimes, in other operations upon the leg, the artery has been secured by acupressure after deligation had failed, as in the following instance:—

CASE XX.—*Division of a Tibial Artery—Acupressure.*—A man, aged 21, received a compound fracture of the bones of his right leg. About two months afterwards the shafts of the bones had so completely reunited that the patient was able to walk; but there remained two sinuses, one on either side of the tibia, leading to portions of diseased osseous structure. The man became a patient of the Edinburgh Hospital. Mr. Edwards made incisions down to the site of the diseased bone, and removed some dead pieces. During the required incisions and extraction, an artery was divided, which yielded considerable hæmorrhage. Mr. Edwards thought the wounded artery was the posterior tibial. He made attempts to secure the bleeding point by means of the artery-forceps and ligature, but was unsuccessful. He then passed a long acupressure-needle through the cutaneous surface down towards the bleeding point, and compressed it. The hæmorrhage was at once entirely and successfully controlled, and in forty-eight hours the needle was withdrawn.

In the following interesting and important case of recurrent and dangerous hæmorrhages after aneurism and amputation of the lower extremity, the needle succeeded ultimately in closing the vessels in an instance where ligatures were followed several times by dangerous secondary hæmorrhage. The patient was under the very able and skilful care of my friend, Mr. Page of Carlisle.

Case XXI.—*Popliteal Aneurism and Amputation, with Repeated Secondary Hæmorrhages —Ligatures and Acupressure.*—The patient, aged 30, who had served in the army for nine years, was admitted into the Carlisle Infirmary on account of a double popliteal aneurism. Compression of the femoral artery was tried for a time, but had to be desisted from on account of the severe pain it occasioned, and the artery was tied. The ligature came away on the thirteenth day, and secondary hæmorrhage took place. Both extremities of the artery were then ligatured, but secondary hæmorrhage recurred several times, till at last Mr. Page was driven to amputate the thigh at its upper third. Ligatures were applied to the vessels. They separated in the course of a week. On the ninth day secondary hæmorrhage once more supervened, and after about twelve ounces of blood were lost, the bleeding artery was compressed against the bone by means of a needle, with perfect success. The application of a ligature was at first contemplated, but this project was abandoned on account of the manifest difficulty of seizing the orifice of the vessel in the midst of the mass of exuberant granulations which surrounded it, and the very weak and depressed state of the patient. Five days subsequently, another artery which had taken to bleeding was secured by a second needle. After that, there was no more hæmorrhage, and in three weeks the man was discharged cured. In talking over the case, Mr. Page stated to me that he believed acupressure was the means of saving the man's life.[1]

In a very interesting case of repeated and recurring secondary hæmorrhages after amputation of the thigh, reported by my friend, Dr. M'Kinlay of Paisley,[2] acupressure-needles were applied in a position somewhat different from Mr. Page's case, namely, upon the course of the artery or arteries leading to the bleeding points, and not upon the vessels at the bleeding points themselves. The patient was a miner, aged 30. Compound fracture of the tibia of the right leg, and extensive bruising, were produced by the fall upon the limb of an enormous stone, which required to be broken into pieces before the limb could be extricated from below it. In consequence of extensive cellulitis with suppuration, amputation was performed in the lower third of the thigh, twenty-three days after the injury. The arteries were easily secured by ligature. Four days after the operation profuse bleeding supervened, which ceased when pressure was applied to the femoral artery. Next day hæmorrhage again recurred,

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[1] *Page.*—See the "Edinburgh Medical Journal," January 1864, p. 630.

[2] *M'Kinlay.*—See his "Case of Secondary Hæmorrhage, in which the Femoral, External Iliac, and afterwards the Common Iliac Arteries were tied," in the "Edinburgh Medical Journal," March 1864, p. 808. Few practitioners have greater oppor-

tunities than Dr. M'Kinlay of trying a new surgical practice, such as acupressure. Writing me lately on the subject, he observes :— "At this time I cannot speak too highly of the benefits which I have derived from acupressure ; as, from the number of wounds brought under my care in the course of fulfilling my various public appointments, I never am at any time without *needles* in my pocket-book, and now seldom, if ever, do I use ligature-threads."

when it was again restrained by pressure, and "the artery was subsequently secured by means of an acupressure-needle." The needle was not removed till seven days after its introduction. During those seven days there was no bleeding, and the stump was granulating very well. On the third day after the removal of the needle, another large bleeding took place. The acupressure-needle was buried deep in the flap, so as to secure the main trunk, when the hæmorrhage entirely ceased. On the second night afterwards hæmorrhage recurred, when compression upon the femoral artery was had recourse to, and an acupressure-needle was introduced higher up in the stump, with the effect of at once controlling the bleeding. Without any hæmorrhage having recurred, it was deemed right not to trust to the acupressure, but tie the femoral artery. On the tenth day after the application of the ligature to the artery much hæmorrhage again recurred, and a tourniquet was used to restrain it. On the third night hæmorrhage set in once more, and on the next morning a ligature was placed upon the external iliac artery. In performing the operation, little more than a teaspoonful of blood was lost. After twelve days, however, sudden bleeding again supervened, and recurred four hours afterwards. Next day it was resolved in consultation to tie the common iliac artery, which was accordingly done. After this time there was no recurrence of the bleeding, and the patient recovered steadily without a bad symptom. The ligature separated on the thirty-eighth day.

This case cannot be adduced, like Mr. Page's, as an instance where acupressure proved successful after deligation had failed. But in its treatment the needle was as successful at least, if not more so, than the ligature; for during the seven days' use of the first needle, no hæmorrhage took place, and when the second or rather third application of acupressure was in successful use, that hæmostatic method was set aside, and tying of the femoral artery adopted—an operation which did not prevent the recurrence of the secondary hæmorrhage. The compression of the arterial tubes leading to the bleeding point by the acupressure-needles was not apparently found by Dr. M'Kinlay to be attended with any difficulty, and did not require the use of any dissection. The compression, on the other hand, of the femoral artery by the tying of a ligature round it did necessarily require the precedent use of the knife, and of careful dissection—a matter of some note in contrasting the two methods of treatment adopted in the case. Would a continuance of trust, in this instance, in the acupressure-needles—which, at the time of their rejection, were acting successfully in controlling the hæmorrhage—have prevented the necessity of having recourse to the ligature of the femoral, of the external, and of the common iliac arteries?

Dr. Culbard of Dunkeld has related to me a case of wound of a mammary artery, the bleeding from which he found it impossible to arrest either by the use of the ligature or by compression, but where the bleeding was at once and permanently staunched by having recourse to acupressure. I shall give, however, the account of the case in Dr. Culbard's own words.

Case XXII.—*Mammary Abscess—Artery divided in opening the Mamma—Ligature—Acupressure.*—"I was called," writes Dr. Culbard, "to attend Mrs. L. I found her suffering from a very large mammary abscess in her left breast, which I opened, and gave exit to a quantity of healthy pus. After the abscess had emptied itself fully, active hæmorrhage occurred, which I was unable to arrest without plugging the wound. In about two hours I was again sent for, as the hæmorrhage had recurred. I removed the plug, dilated the wound, and attempted to secure the bleeding point by means of a ligature, but was unable to do so. At this time my patient was very faint from the loss of blood. I applied pressure by passing my index finger into the wound and compressing it against my thumb. This I continued to do for about three-quarters of an hour, and as the bleeding had apparently ceased, I again plugged the wound. In about half an hour the bleeding returned. I again tried to apply a ligature, but with no better success than on the previous occasion. My patient was very weak, almost pulseless, with cold sweat standing on her. I now passed a common darning-needle through the outer wall of the abscess, making it bridge over the bleeding point and emerge on the surface. This at once arrested the hæmorrhage. On making my visit in the morning I found my patient comfortable. She had lost no more blood. In the evening I removed the needle, but no bleeding recurred, and her recovery went on steadily and favourably."

Many surgical authors have described how necessary it is, when we try to stop a hæmorrhage from a wounded vessel by external compresses, to pack and accumulate these compresses upon the vessel with great accuracy and steadiness from *without*. The acupressure-needle is a more direct, simple, speedy, and effective compress applied to the wounded artery from *within*.

Sometimes acupressure succeeds where it is difficult to use the ligature with success,—in the instance of small vessels situated in awkward positions, or where there is not enough of the arterial tube projecting to seize with the forceps, as in the following :—

CASE XXIII.—*Ovariotomy.—Vessel bleeding on the Inner Surface of the Abdominal Walls.*—In an instance in which I saw Mr. Spencer Wells per-

Case XXII.—*Mammary Abscess—Artery divided in opening the Mamma—Ligature—Acupressure.*—"I was called," writes Dr. Culbard, "to attend Mrs. L. I found her suffering from a very large mammary abscess in her left breast, which I opened, and gave exit to a quantity of healthy pus. After the abscess had emptied itself fully, active hæmorrhage occurred, which I was unable to arrest without plugging the wound. In about two hours I was again sent for, as the hæmorrhage had recurred. I removed the plug, dilated the wound, and attempted to secure the bleeding point by means of a ligature, but was unable to do so. At this time my patient was very faint from the loss of blood. I applied pressure by passing my index finger into the wound and compressing it against my thumb. This I continued to do for about three-quarters of an hour, and as the bleeding had apparently ceased, I again plugged the wound. In about half an hour the bleeding returned. I again tried to apply a ligature, but with no better success than on the previous occasion. My patient was very weak, almost pulseless, with cold sweat standing on her. I now passed a common darning-needle through the outer wall of the abscess, making it bridge over the bleeding point and emerge on the sur-introduction of a piece of bougie, a small roll of wax or charpie, or any other body of tolerable consistence, into the gaping orifice of the ossified artery,[1] with the hope, either of mechanically shutting or plugging up its bleeding mouth; or of allowing a thread to be placed around its now filled and distended tube. Under the same circumstances Chelius recommends, as a security against after-bleeding, trying to tie the vessel with a broad tape, the smart application of the actual cautery, or the ligature of the principal trunk, above the amputation.[2] But, in such a grave complication acupressure has been found quite safe and sufficient, as seen in the following instance:—

CASE XXIV.—*Acupressure capable of closing an Ossified Artery.*—For mangling of the left foot by a waggon, M. Foucher performed, at the Necker Hospital, Paris, amputation at the lower third of form ovariotomy with his usual great skill and dexterity, the ovarian tumour was pretty firmly fixed to the abdominal walls by old adhesions. After these adhesions were severed and the tumour removed, there were two points on the abdominal peritoneum which bled considerably. One of these bleeding orifices was closed by the application of a silk ligature, which was cut short. The other bleeding orifice was so flat that the attempts to seize it with the forceps and ligature failed; but it was readily closed by passing an acupressure-pin through the abdominal walls, so as to bridge over and compress the bleeding vessel. This mode of arresting the hæmorrhage had the further merit in such an operation, that the head of the needle being left externally, it could be withdrawn at will; while, if the ligature had been used, it was of necessity permanently left within the cavity of the peritoneum.

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[1] *Plug for ossified arteries* — See Cloquet in "Dictionnaire de Médecine, ou Répertoire Général," etc., tom. ii. p. 436 ; Manec's "Treatise upon the Ligature of Arteries," p. 102 ; Velpeau's "Médecine Opératoire," tom. i. p. 314 ; etc. etc.

[2] *Chelius.*—See his "Surgery," by South, vol. ii. p. 899.

Occasionally, when the coats of an artery are much diseased, cartilaginous, or ossified, they are so brittle and friable, that they will not bear the strain of the common silken ligature. In these circumstances, when deligation thus becomes very dangerous or utterly impossible, Petit, Dupuytren, Roux, Manec, and others, recommend the sure, which, up to the last moment, gave us all we asked of it—to wit, complete arrestment of hæmorrhage."[1]

I learn from M. Chassaignac's lately published "Traité des Opérations Chirurgicales," that M. Foucher has successfully used acupressure in another case of ossified artery.

Case XXV.—*Amputation of the Thigh—Main Artery Ossified.*—An old woman at the Hospice des Incurables had amputation of the thigh performed in May 1860. M. Foucher was not dreaming at that time of employing acupressure in the case, but when he wished to apply a ligature upon the femoral artery its indurated and friable walls broke under two successive trials. He then passed below the artery a strong ordinary needle, and the bleeding instantly ceased. The patient made a perfect recovery.[2]

In answer to the third of Mr. Syme's three objections against acupressure—namely, its alleged the leg by the double flap method. He acupressed four bleeding arteries. "It was evident," he says, "to me, as well as to the *Internes* of the Hospital present at the operation, that acupressure constitutes a hæmostatic method speedy and easy of application." On the third morning two of the needles were removed; but gangrene spread rapidly up the limb, pyæmia supervened, and the patient ultimately sank. The needles placed over the anterior and posterior tibials were allowed to remain till the patient died. "At the autopsy," says M. Foucher, "we were enabled to satisfy ourselves that the two needles compressed firmly the anterior and the posterior tibial arteries; and that, on a level with the needles, the walls of the arteries had not undergone the slightest alteration nor destruction. In the interior of the vessels was found an obliterating clot, which, in the case of the posterior tibial, was firmly adhering to the extremity of the cut arterial tube. I may add," he continues, "that the two arteries were ossified for a considerable distance above the wound, and that their walls were rigid and friable. This disposition," he concludes, "or condition of the vessels, which is altogether unfavourable to the employment of the ligature, did not interfere in the slightest degree with the success of acupres-

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[1] *Foucher.*—See the "Edinburgh Medical Journal," May 1860, p. 1048.

[2] *Foucher.*—See M. Chassiagnac's "Traité des Opérations Chirurgicales," 1861, tom. i. p. 400 ; see also the "Bulletin de l'Académie Impérial de Médecine," tom. xxv. p. 1087.

"most limited extent"—I have already stated, that under one or other of its forms, it was applicable to most if not to all the wound-complications in which deligation was used; and in the present chapter I have further shown that "the needle-process," as Mr. Syme terms it, has already—during the brief period that has elapsed since I first suggested it—succeeded in various cases, and under various circumstances, both in primary and in secondary hæmorrhage, in which the ligature had already failed. As another proof of this last statement, let me in conclusion adduce one instance of secondary hæmorrhage from the umbilical cord, treated and recorded by Mr. Syme himself. In this case, after the cautery, etc., had failed, he successfully adopted a plan previously described and tried by Dr. Radford, and which consisted of a kind of rude acupressure—applied not so much to the bleeding artery as to the entire circle of the conical cavity of the wound from which the blood was issuing. The case is recorded by Mr. Syme in the third edition of his "Principles of Surgery."

Case XXVI.—*Secondary Hæmorrhage from the Umbilical Ring, in an Infant.*—After describing the arrestment of bleeding from leech-bites by Anthony White's plan (see footnote, page 171, *ante*), namely, by transfixing the wound by a sewing-needle, and tying a thread tightly round it, Mr. Syme proceeds:—"In the same way was subdued a hemorrhage from the umbilicus of an infant, two weeks old, which I saw with Dr. Begbie, and where the actual cautery had been used in vain, at the suggestion of the late Dr. Hamilton, who said that the very few cases of the same kind previously seen by him had proved fatal. I passed," adds Mr. Syme, "two sewing-needles, crosswise, as deep as possible through the conical cavity from which the blood proceeded, and then tied a thread round them."[1]

I have said that the acupressure used in this case was of a rude kind. But, in truth, the use of the cross needles in it was not to compress with them the tube or orifice of the open artery, as in acupressure, but to prevent the thread which was used for this purpose from slipping off; and the compression was not applied to the single bleeding vessel, but to the whole bleeding wound. At the most it had the same kind of indefinite relation to true acupressure as ligature of a vascular part *en masse* or in slump has to the ligature of individual vessels. The surgical ligature of single arteries was only practically introduced, according to most writes, three centuries ago, in the time of Paré; but others maintain that it was sufficiently known some seventeen or eighteen centuries ago, in the time of Galen and Celsus. Yet no one would surely argue that the credit of the discovery of deligation did not belong to the era of Paré, or of Galen, or Celsus, because the wholesale ligature of three vessels *en masse* had been practised for many, many long ages earlier than the earliest of these authorities in that oldest perhaps of all old surgical operations—namely, in the ligature and division of the umbilical cord of the new-born infant.

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[1] *Syme.*—See his "Principles of Surgery," 3d edit., p. 91.

CHAPTER XVII.

ON THE THREAD-COMPRESS OR FILOPRESSURE.

HAVING, in several of the preceding chapters, considered acupressure and some of its results, the general and special objections which have been urged against it, and the chief forms in which it is applied, I propose, in the present chapter, to consider another mode of arresting surgical hæmorrhage, which one of the latest and best writers upon it, and its most strenuous advocate, has described as "in reality but a *modification* of acupressure, from which it differs in detail rather than in principle or *modus operandi*."[1]

The hæmostatic measure to which I allude consists of staying the bleeding in amputation and other wounds, by compressing and binding each bleeding vessel by a duplicature or semicircle of thread or wire, against the sides or walls of the wound, and tying these threads—after they are transmitted through the intervening tissues of the flap—upon the surface of the skin, or over a cushion or bolster placed externally upon that surface. The method consists of the flattening and closure of the vessel against the walls of the wound, or against the intervening tissues, by a kind of thread-compress or filopressure. In it the artery is thus secured by a semicircle of thread, whilst in deligation it is secured by a complete circle of it.

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[1] *Modification of Acupressure.*—See Mr. Dix in the "Edinburgh Medical Journal," September 1864, p. 213.

The thread-compress, when used with iron or silver wire thread, involves the principle of the metallic compression of bleeding arteries; but the thread-compress itself has long been employed in surgery with silk, flax, or organic threads. Acupressure is new and original, as far as I know, in its action and application. The closure of arteries, however, by the thread-compress is a form of hæmostatics which was described and employed by many of the older surgeons; though, till lately it had become in a great measure discarded from practice.

The earliest notice which I have happened to meet with of this mode of arresting surgical bleeding, is contained in the "Compendium Chirurgiæ," of Marianus Sanctus, a Neapolitan practitioner, who published the work named in 1543. When treating of hæmorrhages from incised and other wounds, he makes the following explicit statement regarding his use of the thread-compress in the occlusion of bleeding vessels:—"I have transfixed the lip of a wound above from one side with a needle, down to the cut vein, which I left untouched by the needle. I then conveyed the same needle under the vein to the other side, and transfixed the lip again from below upwards. In this way we formed a noose on the cut vein, and, by firmly tying the ends, bound the vein and the lip together."[1]

Ten years later, another celebrated Neapolitan surgeon, Alphonsius Ferrius, physician to Pope

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[1] *Sanctus.*—See his "Compendium Chirurgiæ" in Gessner's "Scriptores Veteres," p. 161.

Paul III., published a work on gunshot and other wounds, in which he describes the same method. In speaking of the cure of external wounds: "First and principally," says he, "is the escape of blood to be stayed, lest with the blood which is the treasure of life, life itself fly." After recommending, as hæmostatics for this purpose, some medicinal and caustic, etc., applications, Ferri goes on to observe:—"If these remedies are defeated by the blood, we must resort to snaring (*ad illaqueationem*) of the vein or artery. It is performed in the following manner:—Let there be, for example, a transverse wound in the wrist of the hand. Then three or four fingers above the joint, the artery or vein is to be caught up with

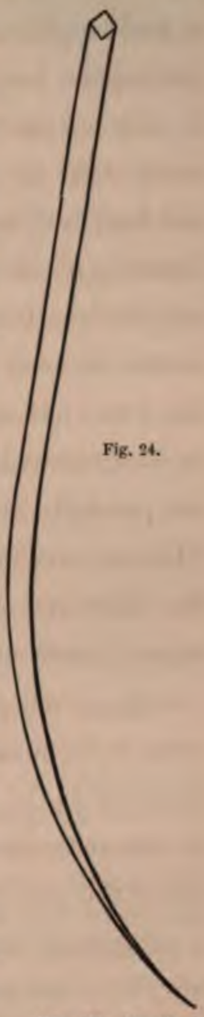

Fig. 24.

Fig. 24. Needle of Ferrius for the application of the thread-compress.

a needle. The needle should be made of iron, half a palm long, square, with blunted sides, that it may not cut in passing through, and straight, except near the point, where it ought to be curved and bent back towards the eye. With the needle accordingly carrying a double thread, let the vein only or the artery be caught. In this, a knowledge of anatomy will be of much service. Then, with the two ends of the thread, it [the vessel] is to be embraced from above tightly, but yet not too painfully, [over] a cushion formed of many folds, or [over] several cushions, laid the one upon the other, and not to be let go till you think the vein or artery conglutinated."[1] To this account of the thread-compress Ferrius adds a figure of the formidable needle which he employed in making the thread-compress. This needle is copied in a shortened form in Fig. 24.

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[1] *Ferrius.*—"Hoc modo fit. Sit, exempli gratiâ, transversum vulnus in rascetâ manus, tum supra ejus juncturam tribus aut quaternis digitis vena vel arteria acu deprehendenda est. Quæ sanè acus ferrea sit, longa semipalmum, tum retusis lateribus quadrata ne in transeundo intercidat, ac recta nisi propè cuspidem, quâ parte falcatam ac retortam ad basis foramen esse oportet. Eâ itaque duplex filum ducente vena solum sive arteria prehendatur. In quo plurimum juverit anatomica cognitio, deinde duobus hinc-inde fili capitibus pulvinum plurimâ duplicatione constantem, seu plures alterum alteri impositos supernè ac strictim non nimio tamen cum dolore comprehendendum est, nec dimittendum usquam dum venæ vel arteriæ conglutinationem factam existimes."—(See

Eleven years after the date of Ferri's work, or in 1564, Ambrose Paré published his account of the ligature of arteries in amputations, and he describes as his second mode of arresting hæmorrhage by threads instead of caustics, the same compression of the bleeding vessel against the sides or flaps of the wound, and the tying of the threads over a bolster placed upon the external skin. In treating of the hæmorrhage following amputation, Paré first describes, in one chapter, "How to stanch the bleeding when the member is taken off." This chapter we have cited in full at page 190, etc. It includes his account of securing the blood-vessels by artery-forceps and ligature. He has next a short chapter on "How, after the blood is stanched, you must dresse the wounded member," and then comes the chapter with this

his work—"De Sclopetorum sive Archibusorum Vulneribus," lib. ii., cap. v., and in Gessner's "Scriptores Veteres," p. 294.)

title, "How you must stoppe the bleeding if any of the bound up vessels chance to get loose." This last chapter contains his account of the thread-compress and its uses:—

"The businesse hitherto being performed, as we said, if, peradventure, it happen that any bandage of any of the vessels be unloosed, then must you againe binde the member with that kinde of ligature which you did before the amputation thereof. Or else, which is better, more easily, and lesse painefull: Let your servant, taking hold of the member with both his hands, pressing his fingers strait, stoppe the passage of the loosed vessell, for so hee may stanch the bleeding." Paré goes on to tell us how the hæmorrhage may be arrested by compressing the artery against the side or flap, and to accomplish this purpose, he uses a long needle to make the semicircle of the closed vessel, first passing in this needle from the cutaneous surface to the inner side of the bleeding point, and then back again from this point to the cutaneous surface. To use again his own words— "Let the Worke-Master," says he, "take a needle some foure fingers long, square, and having sharpe edges, drawing after it a three or foure doubled strong thred. With this let him binde the vessel after the following manner. Let him thrust his needle on the outside into the flesh, some halfe fingers breadth from the loosed vessell untill he come to the end thereof; then let him put it about it, and bring it backe againe, but so that there be no more than the space of a fingers bredth betweene the going in and comming forth of the needle. In this space let him put a linnen ragge three or foure times doubled, and thereupon binde somewhat straite the two ends of the thred together. For so he shall hinder the knot from hurting the flesh which lyes under it in the bindings, and also adde strength thereto. For so the bound-up orifice of the vessell will, in short space, be agglutinated to the adjoyning flesh, and that so firmely, that there hath never beene seene any one drop of blood to have flowed from a vessell so bound up. But if the blood, which flowes forth, proceede from any small vessell, you must not use this suture and ligature, nor make any such great matter thereof; for it will quickly be stanched by the only application of astringents presently to be mentioned."[1]

In his "Chirurgie Françoise," published in 1594, Jacques Guillemeau, the pupil of Paré, describes at length Paré's mode of securing the vessels in amputation with the thread-compress. He details the mode of encircling the vessel by the single large and long needle, passed first from without inwards, and then from within outwards to the surface of the skin. He uses, in this account, nearly the same terms as Paré himself does. The cutaneous bolster, over which the threads are tied, should, he states, be a small compress made of several folds, and of the size of the little finger. This bolster, he observes, saves the patient from pain, and prevents the knot irritating and cutting the skin. Guillemeau conceived that this special mode of securing bleeding arteries in amputations, should be chiefly had recourse to in instances where the cut artery was strongly retracted, and could not be laid hold of by the crow-bill forceps;[1] or where it happened that the circular ligature of the vessel was insufficient or slipped, and in doing so gave rise to a new flux of blood. He advises recourse to it if either of these accidents happen to the surgeon when he is taken by surprise and unprovided with cauteries to stem the bleeding. Guillemeau gives a sketch illustrating the mode of applying the thread-compress in amputation of the forearm. This sketch is reproduced in woodcut, Fig. 26. Besides showing the needle used, and the thread passed by it, he gives in his dia-

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[1] *Ambrose Paré.*—See his "Workes," p. 460. Mr. South, in his excellent translation of Chelius' "System of Surgery," London, 1847, has extracted and given in full Paré's own account of the thread-compress.—(See that work, vol. i. p. 321.)

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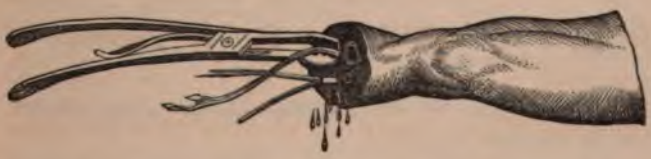
[1] *Application of crow-bill or artery-forceps of Paré and Guillemeau.*—The application of these forceps to the seizure of a bleeding vessel, in a case of amputation of the leg, is given by

Fig. 25.



Guillemeau in a figure, of which woodcut Fig. 25 is a copy. In it it may be observed the crow-bill forceps of Paré is here improved by a spring placed between the handles.

gram a small figure of the cutaneous bolster or compress. Guillemeau states that the thread-compress, when dexterously practised, is very sure in its effects; and he adds that, besides being applicable, under the circumstances alluded to in amputations, it may also readily be made use of in hæmorrhages in all parts of the body, or in great wounds of the thigh, leg, or throat.[1]

Fig. 26.

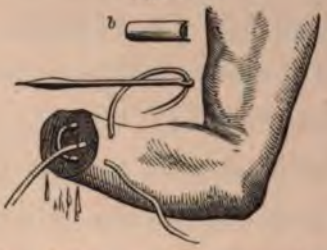


Fig. 26. Application of filopressure after amputation of the forearm; *b*, the cutaneous pad or bolster. (From Guillemeau.)

Some foreign authors, as M. Thévenin,[2] surgeon to King Louis XIV., and Fienus,[3] Professor of

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[1] *Guillemeau.*—See his "Chirurgie Françoise," pp. 108, 109, and the diagrams at p. 15.

[2] *Thévenin*—See his "Œuvres contenant un Traité des Opérations de Chirurgie," etc., Paris, 1658, p. 48.

[3] *Fienus.*—See his "Libri Chirurgici," Frankfort, 1649, or London edition of 1733, p. 161.

Medicine in Louvain, have in their works repeated the account, as given by Paré and Guillemeau, of the plan of compressing the arteries in amputation, by a semicircle instead of a circle of thread, but without adding any additional suggestions. Indeed the next author who makes any step deserving of notice in the employment of the thread-compress is M. Dionis, at the beginning of the last century. Instead of employing, like his predecessors, a single long needle to envelop the artery, this celebrated surgeon used for this purpose two needles, one of which was to be fixed to either end of a single thread, as represented in the little diagram which he gives of it in his plate of instruments required for amputation, and which is copied on a larger scale in the woodcut (Fig. 27), with the cutaneous cushion or bolster (*b*) upon which the threads were to be tied externally. In his chapter on amputations of the lower extremities, Dionis observes that this "sort of ligature consists of two straight needles threaded with the same thread, which is well wax'd. One of these they run through above, and close to the artery, and the other below and close to that vessel; then, to make them come out at the knee-pan (*jarret*) two fingers breadth above the incision which has been made, and a half finger's breadth distant from each other. They tie the two ends of the thread one near the other on a small bolster, in such manner that the vessels are clos'd by the noose made by the thread, and the blood certainly stopt. We are withal to take care the noose of the thread don't take hold of the nerve which is cut, which by being so tightly drawn together would occasion convulsive motions and a palpitation of the heart, which would very sensibly afflict the patient."[1]

Fig. 27.

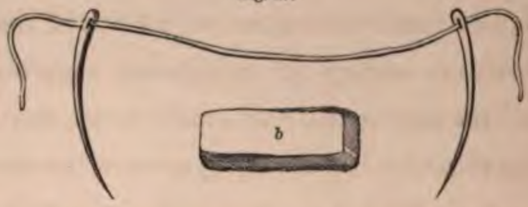

Fig. 27. The needles, one at each end of the thread, for filopressure, with the form of bolster (*b*) on which the threads were tied externally. (From Dionis.)

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[1] *Dionis.*—See his "Course of Chirurgical Operations," p.

The celebrated French surgeon M. Antoine Louis, in his "Memoir on the Amputation of the larger Extremities," quotes the authority of Paré, Guillemeau, and Dionis, in regard to the arrestment of hæmorrhage by this lateral compression of the bleeding vessel, and adds, "It appears that this method is very useful in some respects; by means hereof the vessel might be closed or unstopped at one's pleasure, according to the present circumstances—an advantage which we do not meet with in our manner of tying, because we make a double knot which is hid in the flesh that surrounds the vessel. On the contrary, in the method we are now speaking of, the knot is on the *outside* of the wound, and made with a bow, which may be slackened or drawn tight as shall be judged most convenient, so that here we run no risk of strangulating the parts, as in the manner of tying practised by the moderns."[1]

409; or French edit., Brussels, 1708, p. 509. Dionis' method of using filopressure or the thread-compress is quoted at length in Dr. Thomson's "Lectures on Inflammation," pp. 273-275, etc.

[1] *Louis.*—See the "Memoires de l'Académie Royale de Chirurgie," tom. ii. p. 397; or Neale's English translation, vol. iii. p. 82.

Most of the English surgeons who have mentioned the thread-compress in their works—as Lowe,[1] Wiseman,[2] Read,[3] etc.—speak of it chiefly as applicable to the suppression of hæmorrhage in cases of amputation; but O'Halloran has described it, like Ferri, Guillemeau, and Heister, as suitable to some other surgical operations—and specially to compressing the tubes of the arteries in wounds of the vessels of the wrist and palm. In incised wounds of the arm or thigh, in which the brachial or femoral artery is wounded, he recommends the tourniquet to be first applied, and then, he continues, "with the largest convex needle, armed with six or eight threads, made flat and smooth with wax, I would pierce the skin about an inch above the wound, and near the same distance from the beat of the artery, at one side; pass under the artery, and push the point of the needle out at about half an inch distance at the other side of the artery. The threads being thus passed, and comprehending the artery and surrounding fat and muscular flesh, let a small roller of fine linen, not made up hard, be placed over the artery, and on this let the ligature be made; not very tight, but rather moderately so; as the swelling of the confined *corpus adiposum* and flesh will soon sufficiently compress the vessel so as effectually to prevent bleeding."[1] In illustration of these remarks, let me cite two illustrative cases which O'Halloran gives.

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[1] *Lowe.*—"A Discourse of the Whole Art of Chyrurgerie," p. 93. Lowe recommends the thread-compress after amputations, if the ordinary ligature "slippe as oft it happeneth."

[2] *Wiseman.*—"Several Chirurgicall Treatises," p. 453. He considers the thread-compress "a more easie and sure way of deligation," than taking hold of the vessels with a forceps, and tying a thread around them.

[3] *Read.*—"Chirurgicorum Comes: or the Whole Practice of Chirurgery. Began by the Learned Dr. Read; Continued and Completed by a Member of the College of Physicians in London," p. 610.

CASE XXVII.—*Division of the Radial Artery.*—A patient received a considerable wound of the wrist from a broken pane of glass. The radial artery was cut through, with some smaller ramifications, and bled very freely. The vessels were ligatured; the hæmorrhage ceased, and in seven days the ligature dropped off. Three weeks after the accident, upon a very violent effort being made, the radial artery again ejected blood with great impetuosity. A compress was applied with apparent success. But about five days subsequently a fresh hæmorrhage came on, which was again mastered. It twice recurred again within two or three days, and so violently that "amputation became seriously thought of." Within twenty-four hours the bleeding again returned, and then O'Halloran, as a last resource, passed a convex needle, armed with three threads, about three-fourths of an inch higher up than the gaping orifice of the artery, and some distance from that vessel; pierced the skin and fat, conveyed his needle under it and again out at the other side of the artery, put some lint between the spaces of the wound over the artery, and on this made a pretty tight ligature. "All bleeding immediately ceased, the orifice of the artery soon healed, the skin became firm over this part; in about a fortnight after the ligature cast off, and he now has the use of that hand as firm as the other."[1]

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[1] *O'Halloran.*—See his "Complete Treatise on Gangrene and Sphacelus," etc., p. 156, *sqq.*

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[1] *Thread-compress in wounds of the arteries of the wrist.*—Mr John Bell quotes Mr. White as having used it as well as O'Halloran; and in all probability also M. Deschamps; but M. Deschamps's account is confused and uncertain.—(See Bell's "Principles of Surgery," vol. i. p. 432.) Mr. Bell states (p. 189) that the thread-

O'Halloran gives a case of wound of the temporal artery in which he used the same plan.

CASE XXVIII.—*Thread-Compress applied to the Temporal Artery.*—A man, from stones falling on him, received a considerable wound and fracture of the left parietal bone. Mr. O'Halloran extracted some pieces of the skull which tore through the dura and pia mater. The temporal artery bled with great force. Strong compression was applied to it by means of a pad of lint and a capelline bandage. In half an hour the blood forced through the compress and flowed very copiously. After removing the bandages, and finding every other method useless, Mr. O'Halloran took a small convex needle double-threaded, and pierced with it the skin on one side of the artery, then passed its point under the vessel, and again outwards through the skin on the other side of the artery. He then placed some loose unformed

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compress was employed "even by the Arabians." I have not found any allusion to it in the translations of Arabian authors; and I believe the practice to be Italian in its origin and not Arabian. In the "Gazetta Medica" of Milan, for November 1844, a modern Italian surgeon—Dr. Pagani—proposes to apply the thread-compress—tied upon an external cylinder or bolster of cloth—to the obliteration and cure of varicose veins of the spermatic cord, leg, etc.

lint over the artery, and made his ligature pretty tight over it. "All fear," he adds, "of bleeding from that moment ceased."

Paré gives an analogous case of the wound of an artery in the temporal region produced by a fall, "from whence issued forth blood with great impetuosity. I tooke," he adds, "a needle and thread, and tyed the arterie, and it bled no more after that."[1]

A thread-compress was used by some surgeons of the last century, not in occluding the open mouths of arteries laid open by the amputation-knife, but as a means of compressing and closing the main trunk or trunks of these vessels *before* they reached the surface of the wound. In former days in some amputations, particularly those of the shoulder-joint, it was deemed impossible to compress with the fingers the axillary or the lower subclavian artery with sufficient force and certainty to prevent dangerous hæmorrhages, and in that situation the tourniquet could not be applied. In these advanced modern times the surgeon removes the arm at the shoulder-joint without fear of any formidable bleeding, for he knows he can readily restrain it by having the subclavian pressed against the rib, and by leaving the structures containing the large vessels in the axilla to be the last part divided in the operation. To prevent a fatal rush of blood in this formidable amputation and quartering of the body, several surgeons proposed—towards the middle of the last century—to inclose and occlude the vessels of the axilla and the neighbouring tissues, by including them within a thread-compress before any incisions whatever were attempted. Garengeot gives a detailed notice of this application of the thread-compress, according to the method set down by M. Petit, in the following terms:—"That operation," says he, "is very different from other operations, because no tourniquet is used to stop the blood, and the ligature is made on the vessels *before* the flesh is cut." After raising the patient's arm, and feeling the vessels that run into the armpit, "he takes a crooked and large needle, sharp on both sides, and threaded with a fillet consisting of six or eight threads. He conveys the point of the needle on the side of the armpit and two inches from it. He drives it in till he finds the neck of the humerus, which he scrapes, if I may so say, with the point of the needle, and brings out the point of the needle on the other side of the armpit. . . The needle being driven, as I have just now said, the operator lets down the arm to loosen the skin; afterwards he makes a surgeon's knot with the thread, which he tyes very tight, and as soon as he has made that knot he sees whether the blood be stoped by feeling the artery three or four inches under the ligature, and if he feels no beating he makes a second knot above the first and fastens the two ends of the fillet with a loop. When he has thus stopped the stream of the blood which ran into the whole arm, he must preserve a great deal of the skin, cut the flesh, and extirpate the arm."[1]

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[1] *Paré.*—See his "Workes," p. 1137.

Dr. E. F. Heister, son of the great German surgeon, in a dissertation, "De Nova Brachium

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[1] *Garengeot.*—See his "Treatise of Chirurgical Operations," pp. 521-523. See also Le Dran's "Operations in Surgery," by Gataker, p. 437.

Amputandi Ratione," defended at Helmstadt in March 1739, describes the compression, in the same way, of the axillary artery in amputation of the shoulder, and gives a case in which that operation was adopted for the removal of an arm which was irretrievably damaged and ulcerated over its surface by a severe burn. He gives also a sketch of the patient copied in the woodcut, Fig. 28, representing the ulceration extending to the neck and breast, and the commencement of the application of the thread-compress, passing

Fig. 28.

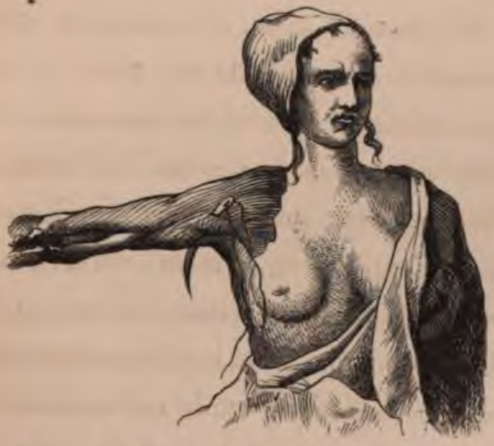

Fig. 28. Application of needle and thread in filopressure to close the axillary artery in amputation at the shoulder. (From Heister.)

a long needle through the axilla and behind the vessels that were to be occluded. "I verily believe," Heister continues, "that I should be advising nothing absurd if, laying aside the tourniquet, I should recommend this method in most amputations of the arm and forearm." And he afterwards remarks, "If we consider this operation [of the thread-compress] attentively, it is apparent that it is applicable more widely than in amputation alone. For in various wounds of the brachial artery, where the bone is severely injured, this perforation of the arm by means of a large needle, and the constriction of the artery by the thread, will furnish a remedy for restraining the flow of blood, at once safe, certain, and speedy. . . . In fine," he observes, "I do not hesitate to affirm that in aneurisms themselves, whether false or true, situated about the upper part of the brachial artery, this method of cure offers singular advantages." "Sometimes," Heister further remarks, "from various causes, an artery sloughs in wounds and aneurisms, as several authors have noticed, and as has been observed by my father also. In this case, though the artery be tied, it is easily torn across by the thread, or broken through by the force of the blood, and hence dangerous, and, by and by, fatal loss of blood follows—an accident that in our method of proceeding is scarcely to be dreaded." And, "our method commends itself extremely, both on account of its simplicity—because fewer instruments are required—and on account of its rapidity." "The same expedients," he adds, "whose utility in amputation of the arm or wounds of the brachial artery I have set forth, can be applied with happy success in various lesions of the thigh and of the femoral artery, especially in those which require amputation."[1]

In the preceding retrospect we have found a series of stages of advance in the use and application of the thread-compress—(1.) Santi applied the compress, tying the knot upon the unprotected skin; (2.) Ferri introduced the use of the bolster or cushion to tie the threads upon; (3.)

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[1] *Heister.*—See Haller's "Disputationes Chirurgicæ," tom. v. p. 224, *sqq.*

These authors used a thread-compress in common incised wounds, but Paré applied it to amputation-wounds; (4.) Up to the time of Dionis the thread was introduced by the use of one long needle, which was passed twice in order to surround the vessel—namely, first from without inwards, and then from within outwards; but Dionis expedited the process by using two needles—applying one to each end of the thread, and passing both from the internal surface of the wound to the cutaneous surface of the flap.

When studying in 1859 the effects of the circular ligature of vessels now commonly used by surgeons, and considering the means by which it was possible to avoid strangulating and sloughing the tied point of the artery, I had repeatedly occasion to look at the action and effects of the thread-compress as described by Paré, Dionis, and others. But I was led to believe that it had been found objectionable in practice from its having fallen into entire disuse, and I spoke only of acupressure in my first communication on this subject to the Royal Society of Edinburgh in December

1859. Within a few weeks after that communication was published, Mr. Hilliard, an ingenious instrument-maker of Glasgow—evidently unaware of all previous writings in the matter—sent me a model and explanation of the thread-compress by which the plan of Dionis—as consisting of the simultaneous use of two needles—was exactly followed—being modified only by the substitution of a thread of iron-wire instead of a thread of hemp or silk. The mere material, of course, of which the thread is made may modify the safety of the operation, but it does not alter the character of the operation itself. Some months afterwards, Mr. Dix of Hull, to whom Mr. Hilliard[1] had also sent his model and proposal, put the plan in practice in three cases of amputation of the finger, foot, and thigh, in a case of removal of the testicle, and in another of removal of the mamma; and, in January 1863, he read before the Medico-Chirurgical Society of London, a very ingenious and able paper on the subject, which has been published in the "Edinburgh Medical Journal" for September 1864. Mr. Dix speaks of the method under the name of the "wire-compress," and he describes the application and removal of the apparatus in the following terms:—

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[1] *Hilliard.*—See the "Medical Times" for 7th February and 7th March 1863.

"Take a piece of surgical wire six or eight inches long, and thread each end thereof upon a straight needle. Seize the bleeding mouth of the artery with forceps, and pass one of the aforesaid needles close on each side of the artery about a line above the points of the forceps, directly down through the substance of the flap, so that they emerge at the cuticular surface, about half an inch distant from each other. Draw them both through together till the curve of the wire compresses the vessel on the face of the flap. Now get rid of the needles by clipping through the wire close above their eyes, also detach the artery-forceps. Place a piece of cork, cut for the occasion, upon the skin, between the points of exit of the wire, and over this twist the wire tighter and tighter until the bleeding is arrested. Lastly, cut off the superfluous wire. All which is done much quicker than described. Repeat this process upon as many vessels as require it. Two arteries lying near together may be embraced by one wire, and, as I have said, the veins may be included or excluded at will. The wire should be either silver—or, what is much cheaper and equally manageable—the finest and softest passive iron. . . Special care is necessary in threading the wire that it be kept perfectly free from all kinking or twisting. The forceps are used, not to draw out the artery as when a ligature has to be applied—this, indeed, is to be particularly avoided—but merely as a guide to mark the exact position and course of the vessel. The cork is necessary to protect the skin from the pressure of the wire." Mr. Dix's directions for the withdrawal of the wire are as follows:—"Clip the wire close to the edge of the piece of cork, and straighten out the curve it has necessarily formed at its exit from the skin. Remove the cork, and apply instead the tip of one finger, with which press firmly upon the flap, making traction gently and gradually upon the other end of the wire. In this way it comes out with great facility; but if this were roughly and harshly done it might break up the adhesion which we suppose has taken place between the surfaces of the flaps, and it is quite possible that a kink in the wire might lacerate the artery in passing over it."[1]

In consequence of my published observations on acupressure, the eminent Berlin surgeon Professor Langenbeck had his attention directed to the evils of the circular deligation of arteries, and endeavoured to overcome them by using a thread-compress exactly of the kind recommended by Dionis and latterly by Mr. Dix:—passing it, namely, semicircularly round the bleeding vessel by two needles attached one to each end of a common thread. He used iron-wire as his compressing agent. An account of a series of amputations in which Langenbeck employed the thread-compress, has been given by Dr. Carl Martin, in an able and interesting dissertation, entitled, "Ansa Fili Metallici, Nova Methodus

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[1] *Mr. Dix's method of application, etc.*—See the "Medical Times and Gazette" for 24th January 1863, p. 94; and the "Edinburgh Medical Journal," September 1864, p. 214.

Hæmostatica," defended before the University of Berlin on the 10th October 1861. The title of Dr. Martin's thesis indicates that the previous use of the thread-compress by the older surgeons had altogether apparently escaped his notice.

Dr. Martin appends some diagrams, illustrative of the application and action of the thread-compress. One of these diagrams, copied in the woodcut, Fig. 29, represents a longitudinal section of an amputation-flap, with a thread-compress and cutaneous pad applied, so as to compress the tube of the artery passing through it. Another of his diagrams, copied in woodcut, Fig. 30, shows, in the form of a scheme, a transverse section of the leg after amputation, with four arteries secured by four thread-compresses. This last scheme represents the several arteries, and the mode of securing them by a thread-compress, as

Fig. 29.

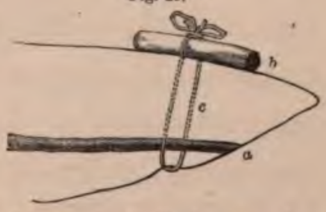

Fig. 29. Longitudinal section of an amputation-flap, showing an artery traversing it (*a*), secured by a thread-compress (*c*), and laid upon a cutaneous bolster (*b*). (From Martin.)

actually practised in one of his cases by Professor Langenbeck. His experience, however, with the

Fig. 30.

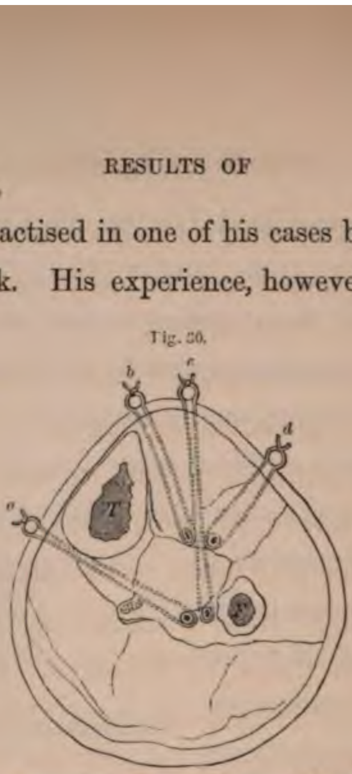

Fig. 30. Transverse section of a recent amputation-stump below the knee, showing four vessels secured by four thread-compresses (*a*, *b*, *c*, and *d*). *F*, section of the fibula ; *T*, of the tibia. (Martin.)

thread-compress, in several amputations, was not such as to induce him to continue it. Out of five cases recorded by Dr. Martin—namely, three amputations of the thigh, and two of the leg—in which the thread-compress was used, three of the patients died, and the remaining two made tedious recoveries. It is but right to add, that in these operations Professor Langenbeck usually tied the smaller arteries with circular ligatures of iron-thread; and he left his thread-compresses on for an unnecessary length of time, varying from three to fourteen days.

The thread-compress, besides being used by many practitioners for securing the orifices of the vessels cut across in amputation and other open wounds, has been employed also as described by Ferri, Heister, O'Halloran, and others, to compress and occlude the tubes of arteries in their course.

Professor Bruns[1] of Tübingen states that in 1830 the elder Langenbeck of Göttingen successfully closed, with a thread-compress, the tube of a temporal artery after dangerous bleeding had recurred for many days—a procedure which we have already seen adopted by Paré and O'Halloran in relation to the same vessel. (See *ante*, pp. 327 and 328.)

During the present year, 1864, Dr. Neudörfer of Prague, apparently unacquainted with any previous effort in the same direction—has proposed a means of compressing and occluding arterial trunks supplying aneurisms by a process to which he gives the name of artery-closure ("Arterienclausur").[1] But Dr. Neudörfer's plan consists of nothing but the application of the thread-compress for this purpose, and exactly in the way previously described for the same indication by Mr. Dix. With this view, Mr. Dix suggests that in the operation, for instance, for occluding the femoral artery in popliteal aneurism, the usual incisions should be made down upon the vessel, and an iron thread passed under the artery by means of a tubular aneurism needle. The two ends of the passed wire should be then threaded upon two common needles, which are subsequently driven through the sides of the wound and brought out at a convenient situation on either side, so as to allow them to be tied or twisted upon a bolster or pad placed upon the cutaneous surface. The sides of the wound would then be brought together without any ligature or foreign body being included between them, so as to have every chance of cohering entirely by primary union; while the wire, removed by the usual way in three or four days, would sufficiently occlude the artery without ulcerating or sloughing through its coats;—so far averting the mischances of secondary hæmorrhage.[1] Dr. Neudörfer's method is in principle and detail exactly the same as Mr. Dix's, and the only thing new in it is, that Dr. Neudörfer gives the operation a new name, and uses either iron-wire or silk thread instead of iron-wire exclusively.

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[1] *Bruns.*—See his "Handbuch der Praktischen Chirurgie," T. iv. p. 147. See also Tavignot's paper on the subcutaneous ligature of superficial arteries, in the "Examinateur Médical" for February 1842.

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[1] *Neudörfer.*—See his "Handbuch der Kriegschirurgie," p. 433, *sqq.*

The kind of pad or bolster employed to protect the skin, in the use of the thread-compress, is recommended to be made of different materials by different authors. Ferri and Paré used a piece of folded rag or cloth; Dionis apparently a pad of charpie; and Mr. Dix a compress of cork. In a communication and model of a wire-thread compress, on precisely the same principle as that of

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[1] *Dix.*—See his observations on this subject in his paper in the "Edinburgh Medical Journal" for September 1864 p. 216.

Dionis, which I received from my friend Dr. Turner of Keith, that gentleman, not knowing what had been done in old and in modern surgery in the matter, suggested a bolster of india-rubber or leather, with metal eyelets fixed in it for the passing of threads, like those used for the lacing of shoes.

The thread-compress is not a measure adapted to the closure of all arteries in all wounds. It is scarcely applicable to arteries opening upon a vertical wounded surface, as in some forms of circular amputation; and it is quite inapplicable to vessels lying open upon the floor of a wound, such as we see sometimes after excision of the mamma and other deep-seated tumours. In these cases, however, acupressure, like the ligature, can readily be employed.

The use of the wire-compress in any wound where several vessels are opened, infers the piercing twice through and through of the entire thickness of the sides and flaps of the wound for every artery that is secured, and the puckering up and displacement, to a certain extent, of the tissues at the compressed arterial point. But it implies what perhaps is much more objectionable—the compression, at each bleeding point, of the whole thickness of the flap or side of the wound from that point to the opposed surface of the skin on which the pad is placed. All the tissues included within the circuit or grasp of each compressing thread, from the surface of the wound to the surface of the skin, are at first compressed with such a force as is deemed necessary to occlude the tube of the bleeding artery. A scheme or diagram, Fig. 31,[1] showing the effects of the application of the thread-compress to the occlusion of a *single* vessel in an amputation of the thigh, and the circuit or area of compressed tissues which it involves, may afford us some idea of the unfavourable effects of *several* thread-compresses upon the general structures forming the flaps of a wound when several vessels are occluded by the process. But this force is betimes much increased with the increasing tension and swelling which are liable speedily to follow upon such systematic compression and irritation of the included parts. And, as a consequence, an obstruction of the capillary circulation, with œdema, etc., is apt to supervene, both in the parts included within the area of the thread-compress and in the structures lying immediately beyond them and vascularly connected with them. If such semi-morbid or morbid conditions arise, the

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[1] *Scheme, Fig.* 31.—The artist has, for the sake of illustration, represented the compressed artery of its natural dimensions, but the surrounding tissues and limb as greatly reduced in size.

Fig. 31.

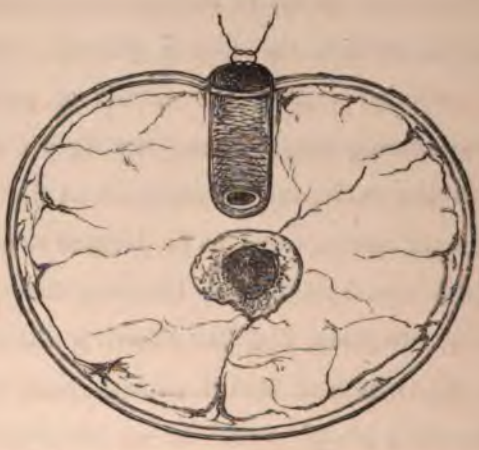

Fig. 31. Scheme showing the extensive compressing action of the *direct* thread-compress.

process of natural adhesion between the sides of the wound must be apt to be disturbed and interfered with; and when two, four, six, or more such portions of the flaps or walls of the wound are grasped, compressed, and swollen in this manner, these walls can scarcely be looked upon as placed in the conditions most favourable to primary union. (See Dr. Martin's illustrative sketch in Fig. 30, p. 340.) There is, however, a marked advantage in the thread-compress over the ligature in this respect, that the compressed arterial tubes are not physically torn and strangulated so as to ulcerate and slough, as they always unavoidably are in the common form of circular deligation.

Perhaps, if the thread-compress became reintroduced into practice, it might be so modified in its application as to avoid that continuous compression of tissues between the inner surface of the wound and the cutaneous surface which constitutes the leading objection to it. On the dead body, as well as the living, I have used it as represented in the accompanying diagram, Fig. 32, so as to contract, as far as possible, the compressed portion of the tissue of the flap to the occluded artery and its more immediate neighbourhood. This I find is easily effected by a modification in the process—by giving the threads, as they are passed outwards, a decussating instead of a direct course. The modification consists in passing each needle, not directly and straightly from the side of the artery to the surface of the skin, but obliquely across and behind the artery, so that the two threads decussate each other in their course; and thus, when they are ultimately adjusted, the por-

Fig. 32.

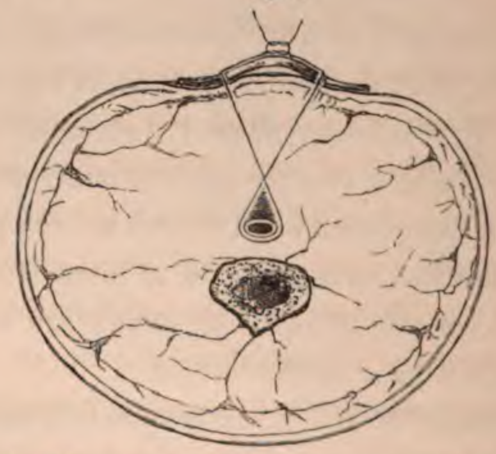

Fig. 32. Scheme showing the limited compressing action of the *decussating* thread-compress.

tion of tissue specially compressed is the artery itself and the structures lying between it and the angle formed by the threads as they cross or intersect behind it. But to render the absence of compression of the more superficial part still more certain, an external broadish bolster placed upon the skin, formed of a piece of concave lead—such as Dr. Bozeman recommended in his so-called "button" in vesico-vaginal fistula—would probably be found of use. Perforated at several points, so as to allow the threads to pass at any two, for the purpose of tying—broad enough to rest at some distance from the points at which the threads emerge from the skin—and with its lower or under surface somewhat concave, it would contribute to reduce the danger of compression and its effects—namely, constriction, swelling, œdema, etc. In this modification of the thread-compress, the area of tissue compressed along with the artery is less in size than when any other process is adopted; and this is a matter of moment. For we know, from operations on hæmorrhoids, etc., that the amount of force required to constrict soft elastic tissue depends much upon the thickness and dimensions of the included structures, and that when the inclosed part is smaller in bulk, a smaller amount of constrictive force is requisite.

In the withdrawal of the thread-compress the involved and possibly friable arterial tube seems more liable to be injured by the retracting thread than when the needle is withdrawn in acupressure. For always, to a certain extent, the retracting thread turns round, and presses, during its withdrawal, upon the included vessel, somewhat like a rope upon a pulley. I have known bleeding follow from this cause, upon the retraction of iron thread, when used in the thread-compress; and the sharp stiff end of the cut wires may occasionally increase the chances of such a result as it is pulled across the arterial tube. Perhaps a silk thread does not involve the same amount of risk. And though the principle of metallic compression is not followed out when a silken thread is used, yet we must remember, as has been already (see *ante*, p. 87) stated in this essay, that during the first fifty or sixty hours of their use, silken threads do not, as a general law, produce much irritation, and when the thread-compress is used they can generally be withdrawn before that interval has elapsed.

CHAPTER XVIII.

ON ACUPRESSURE BY TRANSFIXION AND PARTIAL ROTATION.

IN the Lancet for September 3, 1864 (p. 280), the correspondent of the Journal at Aberdeen, who had previously expressed himself as not over-favourable to acupressure, has made the following remarks:—

"I have watched, with considerable interest, the progress of three cases of amputation lately performed by Drs. Fiddes and Pirrie, in which acupressure had been employed as a hæmostatic agent with remarkable success. It fully realized the expectations of Professor Simpson; in all of them union took place by first intention. I was particularly struck with one case, where amputation at the middle third of the thigh was performed for scrofulous disease of the knee-joint, which resulted in union by adhesion without the appearance of suppuration in the process of healing, notwithstanding the cachectic state of the patient. The method employed in these cases was that suggested by Dr. Knowles, house-surgeon to the Aberdeen Royal Infirmary. A common needle, provided with a twisted wire, is passed below the bleeding artery, the point is elevated and twisted round the vessel—thus uniting pressure and torsion—and is then pushed into the adjoining tissues. The ear of the needle is brought into a straight line with the opening in the flap, so as to be easily withdrawn by the wire."

The method of effecting acupressure described in the preceding paragraph as practised at Aberdeen, is mentioned by me in the present volume at p. 66, among the methods of effecting acupressure; as follows:—" Or a needle passed through or behind the vessel, and then turned more or less completely around it, so as to twist or contort its mouth or tube before the point of the instrument is fixed by being forced onward into the tissue beyond."

This mode of acupressure formed one of the earliest which I tried in practice, for I employed it in 1860, in a case where Dr. Handyside removed by the knife a cancroid tumour of the vulva. The wall of the wound was perpendicular, and I secured, in the manner detailed, the principal bleeding vessel exposed on it. I employed it also in a case of amputation by Mr. Edwards; but, at the time, it appeared to me that the other methods were preferable. The late experience of the excellent surgical staff at the Aberdeen Hospital, makes me now doubt if I was correct in that opinion; and I think that the highest credit is due to their young and talented house surgeon, Dr. Knowles, for devising, quite independently, this special form of acupressure, and for getting it applied in practice.

In a communication which I have received from Dr. Knowles whilst the preceding sheet was in the press, that gentleman describes the method which he had induced the surgeons at Aberdeen to use, as follows:—"A needle is placed beneath the artery, from right to left, a little above where it is bleeding, taking in as little of the surrounding tissues as possible; the point of the needle is raised, twisted round over the vessel, sufficiently far to compress it, and then pushed into the muscular tissue beyond, which serves to retain the twist thus given to the artery. Needles thus inserted can be withdrawn at any time with great ease. All that is necessary for the performance of this plan is a bayonet-pointed needle, 2½ inches long, having a twisted wire 3 or 4 inches in length attached to it. The needles are to be preferred made of soft-tempered steel, because, when brittle, they are apt to break."

I am indebted to the kindness of Dr. Handyside for the accompanying diagram (see Fig. 33, p. 356) of this method of using acupressure.

In this mode of applying acupressure four movements are given to the needle—(1.) It is entered some lines on one side of the bleeding vessel or point, and driven on till it has passed some lines beyond it; (2.) Its point is then by another movement made to emerge upon the surface of the wound; (3.) A degree of rotation or torsion is next given to the needle, so as to twist the arterial tube or orifice and the included tissues till the vessel is closed; and (4.) The occlusion

Fig. 33.

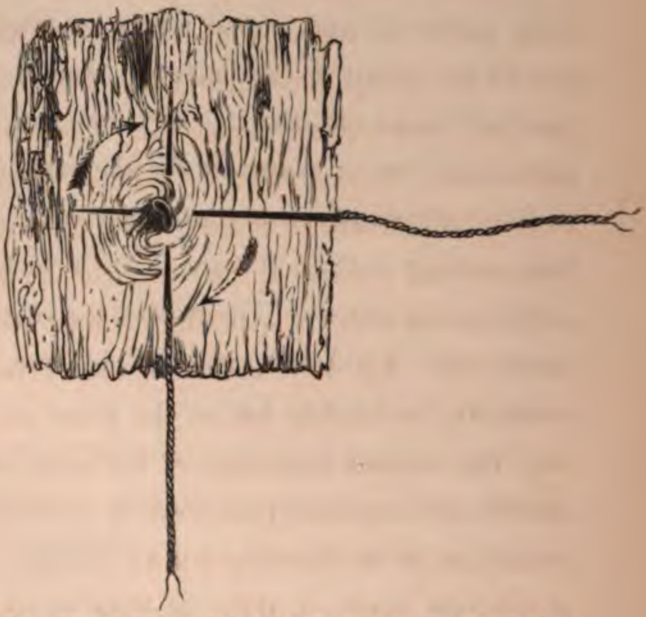

Fig. 33. Diagram of acupressure by transfixion and a quarter rotation of the needle, and the ultimate insertion of the needle-point into the tissue beyond.

being effected, the point of the needle is pushed onward into the soft tissues beyond, to the extent of several lines, in order to fix and maintain the partial torsion of the artery and tissues involved.

The experiments which I have made on the subject, on the dead body, induce me to believe that the second of the preceding needle-movements—namely, the emergence of the point of the needle from under the tissues of the wound to the surface of it—is superfluous; and it is well to avoid here and elsewhere any unnecessary movement or mechanism. Besides, when the point of the needle is again re-introduced, it necessarily more or less depresses and puckers in the surface of the wound at the site at which the needle emerged and was re-entered. All this will be found, I believe, avoidable, by leaving out, as the more common rule, this upward movement of the point of the needle, and restraining the operation (1.) to simple transfixion of the bleeding point; (2.) to a rotation of the needle without making it emerge; and (3.) to the fixture of it by pushing the point onward into the tissue beyond. We are thus, I believe, equally sure to occlude the artery, and much more sure to leave no unnecessary puckering upon the surface of the wound.

The degree of rotation or torsion required to be made by the needle after transfixion, will be found to vary in different cases. A quarter of a circle or even less will generally suffice. But in some exceptional instances, the needle may require to be rotated to a greater degree.

Dr. Knowles recommends a needle two-and-a-half inches long and bayonet-pointed. When an acupressure-needle requires to pass through firm cutaneous tissue, its transit through that tissue is much facilitated by its being made bayonet-shaped. But that shape is not at all requisite when it passes through muscular, connective, and other soft tissues only, as in the modes of acupressure of which we are speaking—except where perchance there is dense fascial or fibrous tissue. Besides, its sharp triangular edges are liable to cut the tissue in the process of rotation, a result which I have seen occur in experiments on the dead body; and a common, properly tempered, strong, round and round-pointed sewing-needle will, I believe, be found to answer equally well and still more safely.

The method of applying acupressure by transfixion and partial rotation is one that can be accomplished with a greater rapidity than the application of the ligature. The needle also can be easily withdrawn by pulling at the wire with which it is threaded, and the end of which is left out. As to the success of the method, in a hæmostatic point of view, let me first quote the words of Dr. Knowles in the communication with which he has favoured me:—"This method," says he, "was first put into practice by Dr. Pirrie at the Aberdeen Infirmary, and, since then, it has been used in five operations, three of which were amputations of the thigh, one of the leg, and one of the forearm. In each case the hæmorrhage was very speedily checked, and there is no doubt that, with a little practice, the needles could be applied in less time than the silk ligature. The stumps were left exposed to the air without dressing—the oozing of blood after the operations being exceedingly little—and the needles were withdrawn in forty-eight hours, in one case seventy-two hours, without a drop of blood following. Three of the subjects were very unhealthy, and union by the first intention failed; but in two of the cases—both thigh-amputations—it completely succeeded, and one of them—a boy—was out of bed, and walking on crutches, exactly fourteen days after the operation."

I am indebted to the kindness of Dr. Pirrie, the very able Professor of Surgery in the University of Aberdeen, for the communication of several cases of amputation in which he has lately employed acupressure instead of the ligature, using the needle by more than one method, but principally by transfixion and rotation. I will cite these cases *verbatim* as sent to me, "and they are," observes Professor Pirrie, "the notes as they were taken down in the hospital books at the time, when there was no intention of publishing them." Professor Pirrie does not consider, like Dr. Knowles and the "Lancet" correspondent, that the cases afforded entirely perfect examples of union by the first intention. "I have not called them," he writes to me, "*perfect* specimens of union by the first intention, as I have never applied these terms to the healing of a wound of any kind where *a single drop* of pus was seen, however gratifying the conditions in all other particulars may have been."

CASE XXIX.—"*Amputation of Thigh—Acupressure.*—A boy, aged 6, had amputation of the thigh performed by Professor Pirrie for disease of the knee-joint, on the 16th of March 1864. Professor Simpson's method by the needle and loop of wire was employed, and the hæmorrhage was successfully checked. The needles were withdrawn in forty-eight hours, and no bleeding followed. The wound healed almost entirely by the first intention, but not completely so, as there certainly was a very little suppuration; but, on the whole, the result was exceedingly satisfactory."

CASE XXX.—"*Amputation of Thigh—Acupressure by the Twist.*—Amputation of the thigh was performed on the 29th of June, upon a girl, aged 13, for disease of the knee-joint. In this case the hæmorrhage was speedily stopped by a new method, which consisted in passing a needle below the artery, giving it a twist over the vessel, and then pushing it into the tissues beyond. The needles were withdrawn in forty-eight hours without a drop of blood following. Although the result of this case was most gratifying, still union by the first intention was not perfect, as a little pus was formed near the margin of the wound." This was the first case, I believe, in which acupressure by transfixion and rotation was tried in Aberdeen.

Case XXXI.—"*Amputation of Thigh—Acupressure by the Twist.*—A man, aged 51, had his thigh amputated on the 20th of July, for disease of the knee-joint, and, at the same time, an enormous hydrocele of twenty years' standing was tapped. Acupressure by the twist was employed, and the hæmorrhage completely checked. The needles were withdrawn in seventy-two hours, and no hæmorrhage occurred. In this patient one angle of the stump refused to heal, and he gradually sank from exhaustion, caused by chronic bronchitis, bed-sores which existed previous to his admission into the hospital, and a purulent discharge from the scrotum."

Case XXXII.—"*Amputation of Leg—Acupressure by the Twist.*—A young man, aged 18, had amputation of the leg performed for disease of the ankle-joint, on the 14th of September. Acupressure by the twist was successfully employed for securing the vessels, and the needles were withdrawn in forty-eight hours without any hæmorrhage. Nearly a fortnight after the operation, secondary hæmorrhage, caused by sloughing of a part of the stump, took place on two or three occasions, but it was easily subdued by elevation and cold. The patient is now progressing favourably."

Dr. Fiddes, one of the Surgeons to the Royal Infirmary of Aberdeen, has also been so good as send me notes of two or three cases in which he has lately employed acupressure :—

Case XXXIII.—*Amputation of the Thigh.*—A boy about 12 years of age was admitted into the hospital with strumous disease of the knee-joint, and extensive abscesses burrowing into the substance of the thigh. The thigh was amputated in the usual way, and the vessels were secured by acupressure, or, to use the words of Dr. Fiddes, "by passing the needle below the artery a little way from its mouth, making the point emerge on the other side of the artery, and then twisting the point over the artery and transfixing it into the tissues of the flap. . . . The needles, three in number, were removed forty-eight hours after the operation. The stump," continues Dr. Fiddes "healed very nearly by the first intention, and the boy was upon crutches walking about in the ward on the fourteenth day after the amputation."

CASE XXXIV.—*Amputation of the Forearm.*—An epileptic was brought into the hospital from the country with both hands extensively burned in consequence of his falling into the fire in a fit. Amputation of the left hand was deemed proper, and after a time it was performed by Dr. Fiddes in the usual way at the middle of the forearm. The bleeding was restrained by acupressure in the way mentioned in the last case with complete success. The needles were removed seventy-two hours after the amputation, and the stump healed kindly though not entirely by the first intention.

Dr. Fiddes reports also to me a case of the successful application of acupressure after excision of the mamma by the needle and looped wire. "I see," he further writes to me, "by the sheet you have sent me, that the plan which Dr. Pirrie and I have lately adopted, on the suggestion of Dr. Knowles, is identical with the plan you speak of in p. 66 of the work which you are preparing."

And he adds, "Acupressure is certainly an improvement on the old-fashioned method of deligation."

A gentleman of great soundness of judgment—as all who have the pleasure of knowing him will gladly acknowledge—Dr. Dalby, R.N., has seen most of the preceding cases of amputation at the Aberdeen hospital, and he writes me as follows regarding acupressure by transfixion and semi-rotation:—"For simplicity and security I do not think it can be surpassed, and all here quite agree on its efficiency as a hæmostatic agent. How any one can be in favour of the common ligature after using acupressure, it is most difficult to understand, especially after seeing the very simple manner in which it is done. If," Dr. Dalby adds, "experience in gunshot wounds should make one a convert to acupressure, I certainly have a fair claim to be one, and I do not know any men who should sooner grasp the thing than those belonging to the army and navy; for all who have seen service must dislike the use of the common ligature, knowing as they do the amount of irritation and suppuration set up by a small piece of a man's clothes in a wound, whereas a clean bullet may be lodged in many cases with very little annoyance, and scarcely any discharge."

When thus treating of the modes of applying acupressure, let me take an opportunity of supplying an omission which I have made when treating on the subject in Chapter VI. The bleeding from a cut vessel is not always arrested by applying the compression from the needle immediately *above* the site of the bleeding orifice; for occasionally, though rarely, the hæmorrhage comes in a direction from below upwards, and not from above downwards. The following case which, very early in the history of acupressure, I published with some few other cases of amputation,[1] will better illustrate my meaning than any longer description. It occurred in the hospital at Carlisle, under the care of my esteemed friend Mr. Page.

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[1] *Amputation.*—See Cases of Amputation with Acupressure in the "Medical Times and Gazette" for Feb. 11, 1860, p. 138.

Case XXXV.—*Amputation below the Knee—Acupressure—Bleeding in one Artery of the Flap from below upwards.*—"The cause leading to the amputation was very extensive, old standing, irremediable disease of the tibia. It is, I believe, generally acknowledged amongst surgeons, that in consequence of the deep situation of the two tibial arteries, between the tibia and fibula, and in proximity to the interosseous ligament, seizure and deligation of these vessels in amputation immediately below the knee are, as a general rule, more difficult to accomplish than the ligature of the arteries cut across in any of the other amputations of the limbs. After Mr. Page had removed the diseased limb in the case in question, I stayed the hæmorrhage from the two tibial arteries by compressing and closing them with two needles introduced through the cutaneous surface of the anterior flap, about half an inch above the level of the ends of the amputated bones. The points of these needles, after producing the requisite degree of compression of the vessels against the bone, were pushed onwards into the substance of the stump behind. They were not, in this way, visible at any point on the raw surface of the stump. The first needle that I passed failed in producing an adequate degree of compression; but the two next succeeded. Half-way down on the inner surface of the large and fleshy posterior flap, an artery gave rise to some difficulty, for a reason which I had not previously been prepared for. I passed a needle through the flap, a few lines on the upper or cardiac side of this bleeding orifice, so as to produce a sufficient degree of compression across the supposed track of the vessel leading to it, but without the effect of arresting the hæmorrhage. On sponging the bleeding point, and examining it more carefully, we found that the jet from the artery was coming from below upwards, and not from above downwards. In consequence of this discovery, I removed the acupressure-needle, passed it through the flap nearer its apex, so as to produce compression two or three lines *below* instead of above the bleeding point—on the peripheral instead of the cardiac side of that point—and the hæmorrhage was forthwith arrested. Mr. Page closed the wound most carefully with a large number of metallic sutures. He withdrew the acupressure-needles seventy-one hours after their introduction. In a letter which I received from him four days after the operation, Mr. Page says: 'The man continues to eat and sleep well. Indeed,' he adds, 'I never had a patient who suffered less after amputation of the leg; and the condition, both of the patient and the stump, is altogether most satisfactory."

At the time at which this operation occurred, I was only acquainted with the one method of effecting acupressure with long needles. In producing acupressure by transfixion and rotation, in the way described in the present chapter, any such error as I have adverted to in the details of the preceding case would be avoided.

CHAPTER XIX.

ACUPRESSURE AS A POSSIBLE DIRECT MEANS OF SAVING LIFE.

SOMETIMES the surgeon is, humanly speaking, the arbiter of his patient's fate. Whether the patient live or die may depend entirely on whether the surgeon operates or not. Nay, the very mode in which he operates may sway and settle the question; for in a case of grave doubt and danger, the method, for example, of removing a shattered or diseased limb may, when the patient is already much shaken or reduced, make all the difference to him between life and death. A mode by which any unnecessary loss of blood is prevented —by which any unnecessary irritation of the wound is avoided—and by which any unnecessary amount of exhausting, suppurative discharges is averted—may turn his fate when that fate is trembling in the balance.

It would be presumptuous, in the present state of our knowledge, to dogmatise to the extent of averring, that in this way the fate of one or more surgical patients has already been decided, by the employment of acupressure instead of deligation in some amputations of the limbs. But I believe acupressure to be a means calculated in this way to save both human suffering and human life. In a case previously detailed (see Case I., p. 71), we have already seen an instance where the highest surgical authority in Scotland refused to amputate the thigh, in consequence of the apparently hopeless state of the patient. But when his limb was amputated, and the bleeding vessels acupressed, union of the wound by the first intention took place, and the man was driving out in his own conveyance six weeks after the operation. In Dr. Handyside's case of amputation of the thigh for traumatic gangrene (see *ante*, Case VIII., p. 145), recovery rapidly took place under circumstances which are usually reckoned by our highest surgical authorities to be perfectly desperate, and even such as forbid any operative interference from its relative hopelessness. "The result," observes Professor Erichsen, "of amputation for traumatic gangrene is on the whole very unfavourable, the patient very commonly sinking from a recurrence of the disease in the stump, or from the constitutional disturbance that had previously set in. Those cases," he adds, "are especially unfavourable in which the cellular tissue of the limb is much infiltrated and disorganised."[1] In treating of mortification as a consequence of mechanical injury to a limb, Sir Benjamin Brodie remarks:—"Where the mortification has been going on for some days, so that the system has begun to be influenced by it, the pulse getting weak, perhaps intermitting, and with great prostration of strength — in such a case you must *not* venture to amputate. Under such circumstances," he continues, "it is probable that the system is not in a state to bear the additional shock of the operation—to say nothing of the loss of blood."[1]

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[1] *Erichsen.*—See his "Science and Art of Surgery," 3d edit. p. 392.

The first case of amputation of the thigh in which acupressure was ever used, was, like Dr. Handyside's case, an instance of the kind described in these extracts; and, in illustration of the view which we have stated, let me cite some of the particulars of it, as published by my friend, Dr. Struthers of Leith:—

CASE XXXVI.—*Amputation of the Middle of the Thigh for Traumatic Spreading Gangrene.*—The patient, aged 40, sustained a compound comminuted fracture of both bones of his leg from a machinery accident. He also had his foot much bruised, as well as the thigh on its posterior aspect, as far up as the hip. Two pieces of the tibia, one of them an inch square, were removed from the wound in the leg, and a M'Intyre splint put on. The limb soon became very much swollen, and on the fifth day free incisions were made into it, and several ounces of fetid bloody pus allowed to drain away. By the ninth day the skin was mottled, and the wound blackish and sloughy. The skin around it crepitated on pressure, and the parts were evidently gangrenous. On the day following, "the whole limb," to quote the words of Dr. Struthers, "from the ankle to the knee, crepitated on pressure; the wound and incisions were sloughy, and the tissues there were dead; the skin over the knee was red, and crepitation was perceptible over the inner condyle and in the popliteal space. The patient had slept none for two nights; was very exhausted, occasionally delirious; pulse 130; countenance sallow and sunk. The limb being now gangrenous and the gangrene spreading, the only chance of life lay in amputation." Mr. Spence and Dr. Gillespie were called in consultation, and Dr. Struthers adds, "we were all of opinion that the case was a desperate one, and that the patient would almost certainly sink whatever means were adopted." It was, however, thought right to remove the dead member; and accordingly Dr. Struthers amputated at the middle of the thigh by the circular method. "On the limb being removed" (I quote Dr. Struthers' own narrative), "Dr. Simpson passed a needle from the inner aspect of the thigh over the femoral artery, about an inch from its cut extremity, bringing its point out in front;

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[1] *Brodie.*—"Lectures Illustrative of Various Subjects in Pathology and Surgery," p. 317.

the needle was passed with great ease, and, to the gratification of all present, completely stopped the flow of blood. The passing of this needle resembled, in rapidity and ease, the passing of an ordinary catheter, and satisfied every one present of the practicability and efficiency of acupressure as a means of arresting hæmorrhage. Five smaller needles were required to stop the other arteries, the mouths of which did not require to be sought for and pulled out, as it sufficed to pass the needle across the tract of the vessel, to which the bleeding point was a guide." After eighty-five hours all the needles were removed, except the one over the femoral artery, which was allowed to remain for ninety-eight hours. In his report on the third day after the operation, Dr. Struthers says—"The stump looked well on the anterior aspect, but on the posterior, the edge of the flap, for the space of three inches by one, was sloughing. The whole of the posterior and outer surface of the thigh looked very suspicious, being quite black from ecchymosis (the result of the original injury); but there was no appearance of the gangrene spreading farther." From this time the progress was very favourable; the slough on the posterior flap soon separated, and before six weeks from the time of the operation, "the stump," says Dr.

Struthers, "which is an excellent one, was entirely healed."[1] This patient remains quite well.

But, without pursuing further this line of argument in favour of acupressure, let us inquire how the ligature is probably connected with the production of Surgical Fever, and consequently with the great fatality of surgical operations, and how acupressure enables us to avoid some of the leading sources of danger that are traceable to the ligature of arteries. For my object is not to show that acupressure may occasionally, and in a few cases act, when contrasted with the ligature, as a direct means of saving human life. What I wish to point out is, that as an indirect means, it may happily contribute to this great end, by enabling the surgeon to avert and avoid some of the leading causes of surgical fever, with its dire train of disastrous consequences. In order, however, to make this view intelligible, let us briefly inquire into the mortality of surgical operations, and the possible relation which the use of the ligature has to that mortality.

[1] *Struthers.*—"Edinburgh Medical Journal," Feb. 1861, p. 692.

CHAPTER XX.

THE HIGH MORTALITY FROM SURGICAL OPERATIONS—IS IT IN ANY WAY THE EFFECT OF THE LIGATURE OF ARTERIES?

THE mortality attendant upon all the larger and severer varieties of surgical operations is something quite striking and startling.[1]

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[1] *Mortality of surgical operations.*—In some lectures published in the "Medical Times" for April and May 1859, on Surgical Fever, and on the causes of death after surgical operations, I took occasion to observe that "Every patient who is placed upon an operating table runs no small risk of death; and when the operation is severe, the patient is in as great, or indeed greater danger than a soldier entering one of the bloodiest and most fatal battle-fields." In corroboration of this statement I remarked, "In the official 'Report of Guy's Hospital' for the year 1856, there is a table of the consequences of 329 operations of all kinds, from which we find, that of these 329 patients, 43 died, or one in every seven and a half. In Dr. Peacock's 'Report' of the Edinburgh Infirmary for the year 1842-43, the results of 150 operations of every kind are tabulated, and this table shows a mortality of one in every five. In the 'Report'

formed in the Parisian Hospitals,[1] from 1836 to 1841, and collected by M. Malgaigne, 281 proved fatal. In other words, 55 out of every 100 thus operated upon died; or more than 1 in 2.[2]

Out of 2046 similar amputations of the limbs occurring in British Hospitals and private practice, collected by Dr. Fenwick, 524 proved fatal. In other words, about 26 in every 100 thus operated upon died; or 1 in 3·9.

Dr. Fenwick has collected together, from civil and military practice in Great Britain, America, and France, a list of 4937 amputations of the

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upon patients in an anæsthetized state, derived from the same British Hospitals as the 284 cases entered in the last column of the preceding table. Of these 145 patients, 37 died, or 25 in 100.—(See my "Obstetric Works," vol. ii. p. 575.)

[1] *Mortality after amputations in the Parisian Hospitals.*—M. Trélat has drawn together a still larger series of statistics of the greater amputations in the hospitals of Paris, from 1850 to 1861. His collection comprehends 1144 amputations in the thigh, leg, arm, forearm, hip-joint, knee-joint, shoulder-joint, elbow-joint, and hand. Of the whole number 522 died, or 1 in 2·2, or nearly 45 in 100.—(See the "Bulletin de l'Académie Impériale de Médecine" for 24th March 1862, p. 591.)

[2] *Malgaigne.*—"Archives Générales de Médecine," 3^{me} Série, tome xiii. pp. 402-411.

limbs. Of these patients 1565 died; or 32 in 100; or 1 in 3·15. "The assertion," adds Dr. Fenwick, "that one person out of every three who suffers an amputation perishes, would have been repudiated a few years ago as a libel upon our professional value; and yet such is the rate of mortality observed in nearly 5000 cases."[1]

The latest and largest individual collection of the statistics of amputations of the limbs which I am acquainted with, does not display any great difference in the general result. Out of 291 amputations of the thigh, leg, arm, and forearm, performed at Guy's Hospital, London, and published in 1859 by Mr. Bryant,[2] 76 proved fatal, making a mortality of 26 in 100; or 1 in 3·8. Again, Messrs. Cooper and Holmes have collated and published the statistics of the same amputations at St. George's Hospital, London, and have shown that out of 149 amputations of the limbs, performed in that hospital for seven years, dating from 1852 onwards, 41 of the patients died, or 27 in 100, or nearly 1 in 3·4.[1]

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[1] *Fenwick.*—See the "Monthly Journal of Medical Science," October 1847, p. 238.

[2] *Bryant.*—See the "Medico-Chirurgical Transactions," vol. xlii. p. 70.

Far less severe and extensive operations than the dismemberment of a limb are followed by no small mortality, when they include the ligature of a large artery. The Hunterian ligature of the femoral artery involves a clean incised wound about three inches only in length, and perhaps an inch in depth. Yet, out of 204 cases, collected and published by Dr. Norris, in which the femoral artery had been ligatured by the Hunterian method, 50 died, or nearly 25 in 100, or 1 in 4. In 188 of these cases, the operation was performed for the cure of aneurism, and 46 of these died, or 24 in 100, or nearly 1 in 4.[2] Mr. Hutchinson has sedulously collected together the statistics of 50 cases of ligature of the femoral artery, performed of late years in the different hospitals of London, and out of these 50 patients 16 died, or nearly 1 in 3.[1]—Perhaps some of my surgical brethren would be inclined to argue stoutly in reference to these statistics of the fatality attendant upon such a small operation as the ligature of the femoral artery, that the mode in which the operation was performed greatly influenced the result; that it would be much less fatal if greater care were taken not to disturb the ligatured vessel from its connections, to any degree above what was absolutely necessary to put a small silk thread around it. But if this argumentation be true—as I believe it is—then it also follows, that if in this operation the vessel be much isolated or detached from its sheath—if a large or broadish ligature be used—or if a double ligature be adopted, as has been sometimes practised—the danger of the operation is greatly increased by such measures. These measures, however, amount to nothing more than an increase and exaggeration of the evil effects and dangers of the use of the ligature, by involving and producing a larger amount of ulceration, suppuration, and sloughing in the ligatured part of the vessel. The danger in the operation is, in other words, not so much the danger of the mere simple incision, as it is the danger of the deligation of the vessel, or rather of the mode and extent to which the vessel is disturbed and disordered by the mode of deligation adopted. At all events, in this instance, it is the ligature of such a large supplying vessel as the femoral, which is the source of peril and death in the operation.

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[1] *Cooper and Holmes.*—See their paper in the "Medical Times" for April 6th, 1861, p. 359.

[2] *Norris.*—See the "American Journal of the Medical Sciences," October 1849, p. 324.

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[1] *Hutchinson.*—See Holmes's "System of Surgery," vol. iii. p. 510; or "Medical Times and Gazette," vol. ii., 1856, p. 515, and vol. i., 1860, pp. 12, 35, 62, 89, and 117.

The Special Source of Danger and Fatality in Surgical Operations.

In relation to these amputations and ligatures, and all other severe operations in surgery, it is most undoubtedly true, that the pathological state or disease which leads to a surgical operation is often much more the cause of the fatal result than the mere surgical operation itself. The operation rather fails to save life than produces death. In herniotomy, for instance, the fatality depends more upon the duration and severity of the previous strangulation of the bowel, than upon the operation itself. The previous existence of, and tendency to peritonitis, are more the source of danger than the actual cutting. But still all large surgical wounds and dismemberments of the body are sufficiently dire and disastrous in their consequences. We have already seen how greatly the presence and effects of the arterial sloughs, produced by the ligature of vessels, necessarily interfere with the local healing and primary union of wounds. But perhaps these ligatures and the strangulated pieces of tissue by which they are retained and affixed in the depths of the wounds, produce still more serious and grave results, by leading on, in many cases, to the excitement of formidable and too often of fatal constitutional fever, in consequence of the introduction into the general system of septic and ichorous matter placed by these ligatures in close contact with the raw absorbing surface of the wound.

Of persons dying after surgical operations, some sink collapsed and exhausted before reaction supervenes; but the great mass of them do not perish under any purely surgical complications, as gangrene, tetanus, hæmorrhage, etc. Out of 153 patients who died after surgical operations or injuries at Guy's Hospital, and whose cases were ably analysed and published by Dr. Cheevers,[1] 18 or 19 only sank under purely surgical complications such as the above; while in 134 of the 153, post-mortem examination found, as the more immediate cause of death, acute inflammatory and other morbid changes in different and distant *internal* organs or structures of the body, as the lungs, liver, pleura, peritoneum, joints,[2] etc. These diffuse internal inflammations and lesions are the acknowledged results of that very frequent and fatal constitutional morbid state, which surgeons have latterly come to speak of under the various names of pyæmia, pyæmic fever, septicæmia, septic fever, traumatic fever, surgical fever, etc.

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[1] *Cheevers.*—See "Guy's Hospital Reports" for 1843, p. 89.

[2] *Internal local acute inflammations found in the bodies of surgical patients after death.*—See some statistics on this matter in Appendix, No. VII.

In one of the most deservedly popular manuals of surgery of the present day, Dr. Druitt defines this very common and very dangerous sequence of surgical operations as "a diseased state of the blood, caused by the introduction of *decomposing animal matter;* often producing rapid effusions of fibrine or of puriform fluid into several internal organs."[1] "The train of morbid phenomena" constituting the disease are developed, says an eminent London pathologist, Dr. Kirkes, "by the introduction into the blood of the elements of pus, or other like disintegrating and *decomposing animal matter.*"[2] Dr. Tanner, again, tells us, that this affection "is a morbid state of the blood, caused by the introduction into it of *ichorous or putrid matters.*[3] According to Mr. Callender, "animal or septic poison, introduced into the system, is the exciting cause of the primary disease, systemic infection."[1] And the great German pathologist Rokitansky lays it down, that pyæmia may be "determined, through infection of the blood, by a foul pus decomposed through stagnation."[2]

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[1] *Druitt.*—"The Surgeon's Vade-Mecum," 8th edit., p. 60.

[2] *Kirkes.*—"Medical Times and Gazette," October 25, 1862, p. 431.

[3] *Tanner.*—"Manual of the Practice of Medicine," 4th edit., p. 21.

That in surgical wounds treated by the process of deligation of arteries, there exists "decomposing animal matter," thus liable to be absorbed from the raw surface of the wound, and introduced into the blood and body of the patient, is a proposition not difficult to prove. Both (1) the ligatures themselves, and (2) the sloughing portions of the arteries which they strangulate and sphacelate, are foci from which such "decomposing animal matter" is most obviously derivable.

1. *The Ligature Threads.*—In various experiments which I made some years ago upon the relative tolerance of the tissues of the living body for metallic and for organic suture-threads, I found that threads of iron and silver, of silk and hemp,

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[1] *Callender.*—See his article on Pyæmia in Holmes's "System of Surgery," vol. i. p. 266.

[2] *Rokitansky.*—See his "Manual of Pathological Anatomy," Sydenham Soc. edit., vol. i. p. 384.

produced, as a general rule, nearly the same amount of irritation during the first two or three days of their insertion. After that time, however, had elapsed, there arose, as a general rule, around the tracks of the organic threads, more or less inflammation or suppuration, whilst the metallic threads did not excite such irritation by their continued presence. If either kind of thread, whether metallic or organic, happened to be so overdrawn as to compress the side of its track too tightly, that side always ulcerated, as I have already stated (see *ante*, p. 103), as the result of the pressure. Making the experiments upon pigs, I further found, that when one of these organic or silk threads, which had been allowed to remain three, four, or more days in the lips of a wound, was taken out and inserted into the bottom of a new wound made upon the back of one of these animals, inflammation — sometimes of a furunculoid or carbuncular form—generally sprang up rapidly around the enclosed thread. Similar pieces of new silk thread, inserted to similar depths in similar wounds on the opposite side of the body of the same animal, did not excite the same speedy and unhealthy morbid reaction in the lips and sides of the wound. I believed at the time—and believe still—that the old suture-threads were thus proved to be capable of being frequent sources of irritation and poisoning to the surrounding tissues; because, after being inserted in living structures for three or four days, they do what metallic threads do not—namely, they swell from the imbibition of animal fluids in contact with them; and these dead, imbibed fluids speedily decompose, and irritate the surrounding living tissues onwards to suppuration. The decomposing animal matters and pus thus retained in the thread rendered it, in the experiments I have spoken of, a nidus of irritation and poisoning to the surrounding tissues when it was buried in the centre of a recent wound.

But in the preceding respects, a silken thread applied to the delegation of an artery does not differ from a silken thread applied to the stitching together of the sides of a wound. A silken suture-thread is nearly as good as an iron or silver suture-thread in cases where it can be safely removed within fifty or sixty hours of its insertion; but while the metallic thread for almost an indefinite time remains innocuous—as far as regards the tolerance of the living tissues for it—the retained silken thread or ligature, containing within its meshes imbibed decomposing animal matter, is always liable and ready to be a source of greater or less irritation to the textures with which it is in contact. Silken ligature threads, when tied around arteries, do not usually ulcerate through the texture which they strangulate, till from four or five to twenty or even more days after they are applied. During that long period they necessarily contain dead animal fluids, and speedily imbibe the pus which is inevitably poured out along their tracks—for they inevitably produce suppuration—and they are thus amply provided, within their own meshes, with the materials of mischief, if these materials are, as we believe them—in the language of Drs. Druitt and Kirkes—to be, "decomposing animal matter."

2. *The Arterial Sloughs.*—In wounds where

arterial ligatures are used, another, and perhaps far more serious, source of such "decomposing animal matter"—of such "ichorous or putrid matters," to use the words of Dr. Tanner—as are capable of exciting pyæmic fever is to be found in the small sphacelating masses or sloughs made by the ligatures in the ends and stumps of the tied arteries. The ichorous putrid matter oozing from all soft tissues in a state of moist mortification or sloughing, is usually believed to be of an irritating and acrid nature. "Mortification," observes Sir Robert Carswell, "of a portion of a limb succeeding to inflammation, to a mechanical injury, to an operation, is often followed by mortification of some internal organ. . . The septic principle," he adds, "is carried into the blood, and appears to give rise to a state of gangrene or sphacelus."[1] "Putrid animal substances," observes Dr. Robert Ferguson, "are among the most noxious poisons to the blood."[2]

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[1] *Carswell.*—See the "Cyclopædia of Practical Medicine," vol. iii. p. 144.

[2] *Ferguson.*—See his "Essays on the Most Important Diseases of Women," Part I. p. 75.

Dr. Fergusson makes this observation in regard to the cause and production of puerperal fever, a disease which I have elsewhere tried to show is analogous with surgical fever. In reference to the same malady—puerperal fever—Dr. Rigby maintains that it essentially consists of "the introduction into the circulation of an animal poison generated by *putrefaction*." "We have long," he observes, "been convinced that one of the causes of puerperal fever is the absorption of putrid matters furnished by the coagula and discharges which are apt to be retained in the uterus and passages after parturition."[1] In reference to the small sloughs and ulcers which are liable to occur in the intestinal canal in continued or typhoid fever, the late Dr. Todd makes a remark perhaps still more pertinent to our case. In that disease, "the sloughing and ulcerative process," as he observes, "furnishes a source of formation of a poisonous matter, which we know, by experience of analogous cases, when taken into the system, creates symptoms of the same character as those of these fatal instances of typhoid fever. . . . One of the worst forms of pyæmia," he adds, "is apt to arise in cases of typhoid fever from the absorption, I believe, of some of the products of the sloughing and ulceration going on in the bowels."[1] There is certainly no reason to believe that the dead, septic, sloughing material of an artery differs in this respect from any other dead, septic, sloughing structure. And in surgical wounds these arterial sloughs, more or fewer in number, are placed in the conditions and situations best adapted for the absorption of their gangrenous discharges; because they are lodged in the depths and centre of the raw wound, and almost closely in contact with the gaping orifices of the veins that run alongside of the tied and gangrenous artery. One surgeon, Mr. Henry Lee, has ingeniously suggested the possibility of preventing the absorption of morbid matter, and consequent blood-poisoning, in cases of inflamed external veins, by applying acupressure higher up in the tube of the affected superficial vein. He has published two or three instances where this practice seemed to be followed by the happiest results.[1] But, in passing, may we not venture to ask whether a similar application of acupressure to the deep veins of a wounded or amputated limb would not sometimes, under similar circumstances, be followed by similar success? At all events, Mr. Lee's and other cases show sufficiently the danger of sphacelating and decomposing tissues being placed in contact or contiguity with the open orifices of veins.

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[1] *Rigby.*—See his "System of Midwifery," pp. 266 and 267.

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[1] *Todd.*—See his "Clinical Lectures on Certain Acute Diseases," pp. 115 and 282.

Possibly, in some exceptional cases, the sanious ichor from the arterial slough may be more deleterious and poisonous than in others. At all events, we see sometimes that the dead bodies of those that die—particularly of puerperal and surgical fever—have all their tissues and fluids of such a poisonous nature, that they dangerously and fatally affect the body of the dissector when introduced into his system in the smallest quantity by the smallest wound. What happens in the way of septic decomposition to the dead body as a whole, may possibly happen now and again to individual dead portions of a body—however small—in the form of local sloughs. Besides, there is one form of slough—viz. hospital gangrene—where contact of the ichor, or, to use the expression of Professor Gross, "of the secretions of a gangrenous sore with a sore of a healthy character," excites a dangerous gangrenous tendency in the latter.[1]

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[1] *Henry Lee.*—See the "British Medical Journal" for January 23d and 30th, 1864.

Surfaces of Wounds capable of Absorbing Morbific Materials placed in contact with them.

That mineral and organic poisons can be absorbed from the surfaces of wounds is testified to by ample experiment and observation. "In recent times," observes Dr. Christison, "Professor Orfila has proved that various poisons, such as arsenic, tartar emetic, and acetate of lead, disappear in part or wholly from wounds into which they had been introduced."[1] "Any ulcer or wound," remarks Dr. Taylor, "is a ready medium for the absorption of poison."[2] "The observation," writes Liebig, "of Magendie, that putrid blood, brain, bile, or pus, when laid on fresh wounds, produces in animals vomiting, languor, and death, after a shorter or longer interval, has not yet been contradicted."[3] I have seen an animal poisoned by materials introduced into an old seton wound. Ulcers and wounds have absorbed poisonous doses of arsenic. We affect the body systematically by dusting strychnine and morphia upon the open surfaces or wounds left by blisters. Further, we have abundance of proofs of the absorption of *animal* poisonous material from wounds in the human body, in the inoculability of small-pox, cow-pox, syphilis, glanders, pustule maligne, etc., and in the fact, that bodies in dissecting-rooms sometimes pass into a certain state of decomposition which is communicable, by punctures and scratches, to the living subject.

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[1] *Gross.*—See his "System of Surgery," 2d edit., vol. i. p. 185.

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[1] *Christison.*—See his "Treatise on Poisons," 4th edit., p. 12.

[2] *Taylor.*—"On Poisons," 2d edit., p. 23.

[3] *Liebig.*—"Letters on Chemistry," 3d edit., p. 229.

Nature of the Poison in Surgical Fever.

Pathologists, up to the present time, are by no means agreed as to what actually constitutes the morbific matter which, when absorbed or imbibed into the blood from wounds, produces the disasters of pyæmic or surgical fever. Some hold that the matter consists of entire pus-globules; others that it is the putrid, thin, or serous portion of the pus; or septic matter not necessarily connected with suppuration; or organized living germs,[1] multiplying, dying, and decomposing in the pus or other morbid wound-discharges, and afterwards in the blood; or in its initial genesis, forms—as I believe more probable—of organic poisons arising from animal, or possibly protolyoic decomposition, more like alkaloids in their chemical type and poisonous effects than aught we can otherwise well compare them to. It is of no moment, in reference to our present inquiry, which of these doctrines be true; or whether there be not different species or varieties of septic or surgical fever due to different species and varieties of the poisonous matter introduced. Allow me, however, to remark, that the morbid materials existing on the raw surface of the wound would probably be absorbed or imbibed even more frequently than they are—and hence the devastations of pyæmic or surgical fever would be greater than they are at present

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[1] *Organic living germs.*—See a most interesting and suggestive lecture on this subject, entitled, "Some Causes of Excessive Mortality after Surgical Operations," by Mr. Spencer Wells, in the "Medical Times and Gazette" for October 1st, 1864. Mr. Wells adduces, and comments with ability on the recent researches and views of Pasteur (see also "Medico-Chirurgical Review," July 1864, p. 102), Chalvet, Eiselt, Davaine, Polli of Milan, etc. "Carrying on," says Mr. Wells, "the analogy between puerperal fever and purulent infection, in the various forms which contribute so large a share to the excessive mortality after surgical operations, and applying the knowledge for which we are indebted to Pasteur, of the presence in the atmosphere of organic germs which will grow, develope, and multiply under favourable conditions, it is easy to understand that some germs find their most appropriate nutriment in the secretions from

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wounds, or in pus, and that they so modify it as to convert it into a poison when absorbed—or that the germs, after development, multiplication, and death, may form a putrid infecting matter—or that they may enter the blood and develope themselves, effecting in the process deadly changes in the circulating fluid."—(P. 351.)

acknowledged to be—were it not, that in a certain proportion of cases the granulating walls of the wound with which the ligatures are in contact, and the ovoid mass of new fibrin or lymph, which surrounds the strangulated and sphacelated end of the artery, form, against the evil influences of absorption, guards which too often give way when the reparative process in the wound in any way fails. Besides, frequent though the disease is, its greater frequency is perhaps still more prevented by the happy prophylactic absence[1] from the blood of an adequate and fit pabulum of organic materials, upon which the poison from the wound —when once absorbed and introduced into the circulating system—could produce the necessary organic changes or ferment which the commonly received theory of puerperal and surgical fever involves.

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[1] *Prophylactic absence, etc.*—See a Note in Appendix, No. VIII., on "Prophylactic Surgery."

CHAPTER XXI.

WHAT ACUPRESSURE AVOIDS IN THE EXCITATION OF SURGICAL FEVER, AND IN THE LOCAL HYGIENE OF SURGICAL WOUNDS.

THE interior of a wound treated by acupressure is in principle so different from the interior of a wound treated by the ligature of its arteries, that there is every reason to believe that, when more generally adopted, the occurrence of pyæmic or surgical fever will become lessened at least and diminished. A long series of careful observations, however, can alone definitely determine this most important matter. But, hypothetically, we would expect such a favourable result to follow, if the present ideas of the best surgical pathologists regarding the origin of this fever in the introduction of decomposing animal matters into the blood, be founded in truth. For (1.) The inevitable presence, in cases of deligation, of as many dead mortified sloughs as there are vessels tied, and the total absence in acupressure of any such irritating putrefying points, form, as we have already seen, one of the principal distinctions between the use of the ligature and of the needle as hæmostatics. (2.) It is scarcely to be doubted that pieces—however small—of dead festering tissue, deeply lodged and embedded in raw wounds for days or even for weeks, could have any other than a dangerous and contaminating influence, both upon the wound and upon the invalid—both upon the rapidity of the patient's recovery and upon the chances of his recovery at all. (3.) The processes of elimination, ulceration, and suppuration, which, in deligation, each individual arterial slough, however minute, necessarily and inevitably excites in the living tissues around it—a process that is totally wanting in acupressure—constitutes another great difference against the use of the ligature and in favour of the use of the needle. Besides, (4.), the body or limbs of the ligature, with its imbibed, decomposing, putrid, and purulent materials, may, in cases of deligation, form, as we have seen, a source of irritation of both a local and a constitutional character. Surgeons have generally, as I am inclined to think, overlooked these various deleterious effects of the ligature, in relation to their local morbific action upon the wound,—but also still more in relation to their morbific action upon the system at large.

In the largest and last work on surgery published in Great Britain, viz. Holmes's "System of Surgery," Mr. Callender, the author of the article on pyæmic or surgical fever, states, that "although no satisfactory explanation can be offered of the fact, it must be assumed that wounds may themselves engender septic matter;" and he observes, a few sentences onwards, that should suppurating wounds "become infected, their treatment must be as simple as possible. All sources of irritation," he adds, "as foreign bodies or accumulations of pus, should be removed," etc. But, no doubt, the ligatures, and the sloughs to which the ligatures are affixed, frequently themselves engender septic matter; and there would be little use in removing foreign bodies or accumulations of pus if we were obliged to leave behind, as deligation necessitates, such foreign bodies and formers of septic and purulent matter. To prevent pyæmic or surgical fever, Mr. Callender correctly advises us, in regard to surgical wounds, that care be "taken to promote their *early* closure; for, when this is attained, exhausting suppuration is avoided, and the disposition to pyæmia is lessened; they should also be kept clean, and free from irritation."[1] Now, all these preventive measures are so far aimed at, and in part attained, by acupressure; and all of them are so far boldly set at defiance when the ligature is employed. Nor is it necessary to insist upon the high importance of such indications as these are in a prophylactic point of view; for here—as elsewhere in medical science—prevention will ever be found safer, and surer, and simpler than cure.

Local Hygiene of Wounds.

In the modern history of medicine no subject has made greater or more solid and successful advances than the study of the prevention of disease — hygiene or sanitary measures. All unprejudiced minds who have attended to the subject, in our own and in other professions, are convinced that the introduction into the body, by inhalation or otherwise, of decomposing animal matters, forms—and particularly under some special conditions of decomposition—a frequent source of debility, disease, and death, and constitutes especially the origin and promoter of various forms of fever. Even in instances where they do not actually produce diseases, they aggravate greatly and dangerously maladies that are excited by other causes. The removal and avoidance of these morbific causes—resulting from organic decompositions—form the acknowledged media by which much human life has been already saved, and much human disease and misery already prevented. But in the surgical patient there are, if I may so speak, *local* as well as general sanitary arrangements to be attended to; for besides the general hygiene of the body of the patient, there is the local hygiene of the wounded or diseased part. Nay more, the sanitary laws that are of the utmost moment for the patient's body, are the same that apply to the patient's wound.

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[1] *Callender.*—See Holmes's "System of Surgery," vol. i. pp. 292, 293, and 298.

The most perfect hygienic state for insuring the health of the general body is simply the most perfect attainable state of general cleanliness as regards abundance of air, abundance of water, freedom from all decomposing materials and effluvia, etc.; and certainly the most perfect hygienic state, for the local wound, is also the most perfect attainable state in it of local cleanliness, in the best and fullest sense of that term.

In the case of a man who is the subject of a large and dangerous surgical wound, to keep spontaneously locked up—and systematically embedded—within the depths of the wound a series of rotting, decomposing dead sloughs, is surely not more irrational than it would be—with deliberate intent and forethought—to submit the body of that man to the morbific influence of a set of uncleanly putrefying organic materials placed immediately around him. "A poison," wisely remarks Mr.

Travers, "admitted by a wound or raw surface, and a poison admitted by the lungs, are equally excitants of a specific constitutional irritation."[1] Nothing, in the whole round of professional practices and customs, seems to me to be a more curious anomaly and paradox, than to watch surgeons sew up with the greatest artistic exactitude and nicety the lips of an amputation or other wound with metallic sutures, while they have waywardly and designedly left, buried in the interior of the wound, a series of silken ligatures, each of which will inevitably produce ulceration and sloughing at the ligatured points. The finished wound is apparently all tidiness and neatness without; but within there are minute strangulated sloughy portions of festering tissue, the sphacelation of which must inevitably be attended by ulceration and suppuration. It is like enforcing cleanliness, as it were, and the best hygienic measures outside a house, whilst within doors there were retained and locked up filth and decomposition, and the explosive elements of destruction and disease. It is, in short, the old story of the "whited sepulchre," "beautiful outwardly," but within "full of all uncleanness."

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[1] *Travers.*—See his "Inquiry concerning Constitutional Irritation," p. 527.

I know some great and gifted surgeons who are perfectly alive to all the startling perils which their patients, after operations, would undergo, if they allowed them to be laid up in a room the air of which was infested with effluvia from dead and putrefying animal matters,—and who would feel utterly startled at the very idea of these patients being recklessly subjected to such unsanitary and unnecessary dangers, especially at a time when their systems were already lowered and depressed by the previous shock of the operating knife. Yet how few—how very few—of these same surgeons hesitate at this moment, in designedly and deliberately submitting these same patients to the analogous but still greater perils, which are inevitably produced by needlessly entombing dead and putrefying animal materials within the depths of those very wounds which their scalpels have inflicted! They take all possible means to prevent any dead animal materials from being inhaled by the lungs of their patients,—and no pains whatever to prevent similar dead animal materials from being imbibed by the open surfaces of their wounds. Nay, they determinedly place and plant dead and festering animal matters in the closest possible contact with the fresh absorbing surfaces of their patients' wounds, and sew and lock them up there, as if for the very purpose of enforcing and assuring their imbibition, whilst they equally determinedly preclude the inhalation of any such materials by the process of respiration. It is impossible to account for such strange and paradoxical inconsistencies; and yet I fear human nature and human practices are full of them.

In my first communication on acupressure to the Royal Society of Edinburgh, I ventured to draw the following general inferences in regard to the probable results likely to accrue from its introduction into practice; and the experience of the intervening four years has, I believe, already gone far to confirm the correctness of these different inferences :—

"The acupressure of arteries, when compared with the ligature of them, appears, as a means of arresting hæmorrhage, to present various important advantages:—

"1*st*, It will be found more easy, simple, and expeditious in its application than the ligature.

"2*d*, The needles in acupressure can scarcely be considered as foreign bodies in the wound, and may always be entirely removed in two or three days, or as soon as the artery is considered closed; whilst the ligatures are true foreign bodies, and cannot be removed till they have ulcerated through the tied vessels.

"3*d*, The ligature inevitably produces ulceration, suppuration, and gangrene at each arterial point at which it is applied; whilst the closure of arterial tubes by acupressure is not attended by any such severe consequences.

"4*th*, The chances, therefore, of the union of wounds by the first intention should be greater under the arrestment of surgical hæmorrhage by acupressure than the ligature.

"5*th*, Pyæmia and surgical fever seem not unfrequently to be excited by the unhealthy suppuration, etc., in wounds which are liable to be set up by the presence and irritation of the ligatures.

"6*th*, These dangerous and fatal complications are less likely to be excited by the employment of acupressure, seeing the presence of a metallic needle has not the tendency to create local suppurations and sloughs in the wound, such as occur at the seats of arterial ligatures.

"And 7*th*, Hence, under the use of acupressure, we are entitled to expect both, *first*, that surgical wounds will heal more kindly and close more speedily; and, *secondly*, that surgical operations and injuries will be less frequently attended than at present by surgical fever and pyæmia."[1]

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[1] *General inferences on acupressure.*—See the "Edinburgh Medical Journal" for January 1860, p. 650.

CHAPTER XXII.

APPLICATION OF ACUPRESSURE TO OTHER OPERATIONS THAN THE CLOSURE OF ARTERIES IN SURGICAL WOUNDS.

HITHERTO I have spoken chiefly or only of acupressure in relation to its hæmostatic and healing effects upon surgical wounds. But it is applicable to other surgical conditions and circumstances than the mere closure of blood-vessels laid open by accident or by the scalpel. In my first communication[1] on the matter I suggested some other applications of it as follows:—

(1.) "Possibly, in some amputations, an acupressure needle or needles may yet be passed, immediately before the operation, half an inch or so above the proposed site of the amputation-line, so as to shut the principal artery or arteries, and render the operation comparatively bloodless. If so, these needles would serve, at one and the same time, the present uses of both tourniquet and arterial ligatures. (2.) Perhaps this will be found, in some cases, a simple and effectual means of compressing and closing the artery leading to an aneurism—as the femoral artery, for example, in popliteal aneurism—changing the operation for that disease into a simple process of acupuncture instead of a process of delicate dissection and deligation, when in any case the milder methods of compression, manipulation, and continuous flexion of the knee fail. (3.) It has been hitherto a difficult problem to obstruct the vessels of the ovarian ligament in ovariotomy, without leaving a foreign body, whether clamp or ligature, upon the stalk of the tumour, to ulcerate and slough through it. If the stalk be transfixed and pinned in its whole breadth to the interior of the relaxed abdominal walls, by one or more acupressure-needles passed through these abdominal walls from without, this difficulty may possibly be overcome."

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[1] *Proposals in first communication on acupressure.*—See the "Edinburgh Medical Journal" for January 1860, p. 649.

Let us consider somewhat more in detail each of these proposed applications of acupressure :—

1. ACUPRESSURE OF THE TRUNKS OF THE SUPPLYING ARTERIES IN AMPUTATIONS, REMOVAL OF TUMOURS, ETC.—After describing the restraint of hæmorrhage by compressing the arterial trunks supplying the parts of the body that were to be cut through—by means of circular compression of the limb, by the garrot, the tourniquet, the naked hand, etc.—M. Velpeau adds, "In certain cases a still more secure method may be had recourse to. We lay bare the artery at a certain distance from the place where the operation is to be performed, and apply a ligature to it."[1]

I have already cited (p. 258, *ante*) Professors Marjolin and Blandin as having tried this practice in amputation of the limbs. In 1760 Lefébure suggested the propriety of tying the femoral artery before attempting amputation at the hip-joint—a practice which has been followed in that operation by Delpech, Larrey, and others.[1] But, indeed, the compression and ligature of the main artery of a limb that is about to undergo amputation is a very old proposition in surgery. In the writings of Archigenes—the reputed medical friend and attendant of Juvenal—it is stated, that before the limb is cut off, the vessels leading to the site of the amputation are to be tightly bound or stitched together.[2]

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[1] *Velpeau.*—See his "Médecine Opératoire," tom. i. pp. 300-302.

I am not aware that acupressure of the arterial trunk or trunks has been yet tried successfully as a preliminary proceeding to any amputations of the extremities. In one case of amputation of the thigh by Dr. Henderson of Leith for a severe railway injury, I made an attempt, before the incisions were begun, to compress the femoral artery with a long needle, but failed. Others, possessing more surgical dexterity, have succeeded, as in the following case of amputation of a large portion of the lower jaw, by my friend Mr. Spencer Wells.

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[1] *Ligature of the femoral artery before amputation at the hip-joint.*—See Bourgery's "Traité Complet de l'Anatomie," etc., tom. vi. p. 272.

[2] *Archigenes.*—See the "Græcorum Chirurgici Libri," edited by Cocchius, Florence, 1754, p. 157. The words used by Archigenes are as follows:—"Ἀποβροχιστέον οὖν ἢ διαῤῥαπτέον τὰ φέροντα τῶν ἀγγείων ἐπὶ τὴν τομήν."

CASE XXXVII.—*Removal of Portion of Lower Jaw, and Tumour attached to it.—Previous Acupressure of the Facial Artery.*—The patient had a tumour involving the left side of the lower jaw. It covered all the remaining teeth of the left side of that jaw, projected into the mouth, pushed the tongue backwards to the right side, interfered materially with mastication and deglutition, and rendered the voice very low and indistinct. Mr. Wells removed the diseased portion of bone and the tumour by means of a single incision running along below the base of the jaw, from the angle to the symphysis. The cheek was dissected from the tumour, and the jaw divided by saw and cutting forceps close to the angle and to the left side of the symphysis. The resulting wound was united by metallic sutures, and the upper and lower molar teeth upon the right side, were kept in apposition by a small mould of vulcanite, which was removed after twenty-four hours. "Nearly," observes Mr. Wells, "the whole of the wound united by first intention."[1] And, writing to me with regard to the case, he states:—" As to your suggestion to use a needle *before* an operation to check hæmorrhage, or rather to prevent it, it may interest you to know, that I did this lately before excising half the lower jaw. I knew that my first cut would be straight across the facial artery; so I passed a needle under the artery before making the cut. It answered perfectly."

2. ACUPRESSURE OF ARTERIAL TRUNKS LEADING TO ANEURISM.—When a ligature is placed around a large arterial trunk, it is usually a number of days, and sometimes a number of weeks, before it eats its way, by ulceration, etc., through the tube of the vessel, and becomes separated. During all this prolonged interval, the incisions made to reach the vessel are prevented from completely closing by the ligature lying as a foreign body between the lips of the wound; and, moreover, hæmorrhage frequently supervenes from one or other end of the ulcerating artery. If it were possible to flatten and close the arterial trunk merely and

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[1] *Wells.*—See the "Transactions of the Pathological Society of London," vol. xii. (1861) p. 217.

simply by an acupressure needle, or needles, all the tearing of the two internal tunics of the vessel produced by the ligature,—the breaking up of its vital connections from the whole circle of surrounding tissue,—and the indefinite irritation of the ligature-thread, would be avoided; whilst the withdrawal at will of the needle in two or three days,—when the occlusion of the arterial tube was completed,—would serve in a great measure to set aside and avert those dire mischances of local ulceration, sloughing, and secondary hæmorrhage, which have proved such common sources of danger and death in the deligation of the larger arteries of the body.

Most or all of the larger arteries that are ever made the subject of deligation, are so situated in relation to bones, that those bones would readily afford a point, against which the arterial tubes might be readily and successfully compressed. The nerves, however, and veins, by which the arteries are usually accompanied, will be regarded by many authorities as reasons for not having recourse to acupressure in cases of aneurism. But if these can be avoided, as they are in the passage of the aneurism-needle around the artery in deligation, the surgeon may possibly learn to avoid them also, in passing and bridging a long needle over the artery in acupressure—the artery being first exposed, and the long needle passed from below and without inwards, so as to include the arterial tube only, and leave in their normal position, on one or other side, the accompanying vein or nerve.

Perhaps also a method may be discovered, of passing a long needle, sharpened at both ends, down through the bottom of the incision, between the artery and nerve or vein on one side, till the point of the needle emerges, an inch or more, at a proper angle through the skin externally. Afterwards, using that emerged point as a handle, the other or anterior end of the needle may by it be pulled down to the plane or level of the vessel, then passed or bridged over the artery, and ultimately fixed by being driven a few lines into the tissues beyond—avoiding, of course, the vein or nerve that may lie on that side. The long needle, in whatever manner used to bridge over the artery, would require merely to pass over it at such an angle as is sufficient for the full closure of the vessel; and it is to be remembered, that a very slight amount of steady and fixed pressure is quite sufficient for this purpose.

If an artery—such as the femoral or carotid—should be closed by the pressure of a needle, this mode of obliteration would, as is evident, have several very marked advantages over deligation. It would not, for example, tear the artery away from all its organic and vital connections around its whole circumference, as the ligature, and even the thread-compress, when applied to the obliteration of the trunk of a vessel necessarily do (see *ante*, p. 342). It would avoid that complete division, by ulceration and partial sloughing of the tube of the artery, which deligation involves. It would allow the incision down upon the vessel, at once to close by first intention; because it would leave no foreign bodies like ligatures between its walls and lips. It would diminish the mischances of secondary hæmorrhage from the ulceration or sloughing of the canal of the vessel ; for it would be removed fifty or sixty hours after being applied, and hence before any ulceration or sloughing was set up.

In relation to the proposed practice of acupressure in aneurism, let me further observe, that if a long needle should be passed through the skin, and without any preceding dissection, so as partially or entirely to close the arterial tube, the compression of the attendant vein or nerve may not be found so detrimental as theory might suggest. For practically, in the cure of popliteal aneurism by external compression, by the methods which have been so successfully followed in the Dublin school of surgery, the femoral vein and branches of the anterior crural nerve are compressed along with the artery by the external pad or tourniquet used. And we know from the researches carried on in the same great school, that for the cure of popliteal and other aneurisms complete closure of the vessel is not absolutely necessary—its partial or imperfect closure usually proving sufficient for the purpose.

Perhaps a short form of needle, as in the second mode of acupressure (see *ante*, p. 58), may be found to answer in compressing arterial tubes even better than the long. But it is only by experience on the dead as well as on the living body that such questions can be settled. Supposing the usual incisions to be made down upon an artery like the femoral, its sheath opened and the artery exposed, then a short needle, after being passed through the sides of the sheath or any adjoining lateral tissue, might possibly be placed *obliquely* across the tube of the artery, pressed down so as to close it, and ultimately fixed by having its point passed into the tissues beyond. The needle, if sufficiently short, could be readily withdrawn, when required, by pulling at the iron-wire with which it was threaded.

I have closed the carotid artery in the horse by a method which may possibly be found more adapted to the arteries in aneurism, than any of the modes which I have above ventured to suggest. After the carotid was exposed, as in the operation for deligation, I pressed the artery somewhat to one side, and passed a needle on that side of it, driving it onwards so as to fix its point in the tissues beyond. Then I passed a second needle exactly on the opposite side of the vessel, and fixed its point in the same way, and as near as possible to the site of implantation of the point of the first needle. The arterial tube was thus included between two needles, one passed on each side of it, and with their two points impacted and fixed into almost the same point of tissue; while their two eye-extremities were directed externally and still loose. But, by next pressing together these eye-extremities of the needle, and winding round them a duplicature or two of iron-wire, the tube of the artery was at once closed by being compressed between the two needles. In this mode of operating, as in those already described, the needles can be always withdrawn at will by traction at the iron wire or wires by which they are threaded.

It has been already stated (see *ante*, p. 172), that M. Velpeau suggested, that a needle and twisted suture might possibly be applied, for obliterative purposes, to the tubes of arteries supplying aneurisms, as well as to the tubes of varicose veins. I have lately met incidentally, in surgical literature, with one instance in which two small aneurisms and their supplying artery were all severally compressed by needles and twisted sutures, in accordance with the principles of the third plan of acupressure, which I have described (see *ante*, p. 60) for the closure of the mouths of bleeding arteries in wounds. The case I advert to is recorded by Professor Malgaigne in his Operative Medicine.

CASE XXXVIII.—*Small Aneurisms of the Scalp treated by Twisted Sutures.*—The patient had two small aneurismal tumours situated on the frontal region. "I passed," says Malgaigne, "into each tumour two pins which traversed it, crossing at the centre, and I united them together by two threads, like the twisted suture, drawn with sufficient force. I then passed under the cardiac end of the diseased artery, at two centimetres from the aneurism, another pin which embraced with the artery a certain portion of the integuments, and which I secured with a thread like the others.

The pins were left in place twelve days without any sort of accident, and the cure was complete."[1]

In this case the treatment was perhaps more than was necessary; for in all likelihood the compression of the cardiac portion of the arterial tube would have been itself quite enough; and the maintenance of that compression for two or three days—instead of twelve—would have probably sufficed. I have known an aneurism in this position cured by merely compressing the supplying arterial tube with a pad held in position over it by a caoutchouc letter-band.

3. ACUPRESSURE OF THE OVARIAN PEDICLE IN OVARIOTOMY.—On few points in surgery has a greater and more rapid revolution taken place in opinion, in this country, than upon the subject of ovariotomy in cases of ovarian dropsy. To understand the question and its bearings, let me stop to remark, that the first case in which the operation was systematically performed for the

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[1] *Malgaigne.*—See his "Manuel de Médecine Opératoire," 6th edit., p. 203.

cure of that disease,[1] occurred, I believe, in Kentucky, North America, in 1808. The patient consulted Dr. Ephraim M'Dowell of Danville, who refused to operate; but subsequently the tumour was successfully removed by John King, a sow-gelder. Next year, or in 1809, another patient similarly affected consulted Dr. James M'Dowell and his uncle and partner Dr. Ephraim M'Dowell; and the ovarian tumour, weighing with its contents twenty-two pounds, was successfully removed by them. The patient survived for upwards of thirty years, and died at the advanced age of seventy-nine. The nephew, Dr. James M'Dowell, three years afterwards died; and the uncle, Dr. Ephraim M'Dowell, performed the operation, with other practitioners, in a number of successive cases. Of his first seven cases six recovered and one died.[1] Unfortunately, no accurate reckoning of his operations continued to

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[1] *Early ovariotomies.*—The case sometimes quoted from L'Aumonier was certainly not a case of ovariotomy for ovarian dropsy, the only body removed being hard and of the size of an egg, and the mass of the swelling consisting of a puerperal pelvic abscess which was opened. Percival Pott successively removed both ovaries in a healthy state from a patient in whom they appeared externally in the form of inguinal herniæ; and according to Athenæus, Adramyttes, King of Lydia, followed, with other ancient monarchs, the practice of making female eunuchs by the extirpation of the ovaries.—(See the historical notices of the operation in my "Clinical Lectures on the Diseases of Women," Philadelphia, 1863, p. 376.)

[2] *First systematic extirpation of a dropsical ovary by John King.*—"In 1808, a lady of Stamford, Kentucky, called on Dr. E. M'Dowell, to be examined and operated upon by him. He pronounced it a case of ovarian disease, and told her it was incurable, for she must eventually die by the bursting of the tumour in the abdomen. She returned home in despair, but having related her case to an old Indian hunter, who in later life had made his living by speying animals, he proposed to cure her if she would submit to his mode of operation. She said it was but death and she would try it; and accordingly John King opened the abdomen as he would that of a sow or a heifer, and the tumour being pedunculated, he passed a ligature around the neck and cut it off, and in two weeks the woman

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was entirely recovered. Mr. John Camden of New Orleans, and Peter G. Camden, formerly a mayor of this city (St. Louis), will both testify to the correctness of this statement."—(" A Report on the Improvements in the Art and Science of Surgery in the last Fifty Years," by Dr. Joseph N. M'Dowell, St. Louis, 1860, p. 28.

[1] *Dr. M'Dowell's first seven cases.*—His nephew, " Dr. William M'Dowell, who was a member of his family for nearly seven years—five as a student, and two as a partner in practice—states that up to the period of his removal to Fincastle, Virginia, in 1820, his uncle had had seven cases, all, save one, successful."—(See " North American Medico-Chirurgical Review," November 1860, p. 1044.)

be kept, but one of Dr. M'Dowell's biographers tells us, that his success was not "so great in his latter as in his earlier operations."[1] Dr. M'Dowell published, in 1817, in the Philadelphia "Eclectic Repertory," vol. vii. p. 242, an account of his first three cases; and sent a copy of this paper to his old and distinguished preceptor in Edinburgh, Mr. John Bell. This account came into the hands of Mr. Lizars, Lecturer on Anatomy and Surgery in Edinburgh, who republished the cases,[2] and subsequently himself opened the abdominal cavity for the purpose of performing ovariotomy, in four patients. Mr. Lizars had the fortitude and the honour of commencing in Europe, one of the most daring and striking revolutions that has ever taken place in operative surgery; but—chiefly in consequence of a want, at that time, of sufficient diagnostic means—his own success, in regard to ovariotomy, was not great. In the first of his four cases no tumour was found. In a second case the tumour was a pediculated fibroid tumour of the uterus, and was left unremoved. Both these patients recovered. In the remaining two cases the diagnosis was correct, and the ovarian tumours were extirpated. One of these patients died, and the other recovered and lived for years.[1]

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[1] *Biography of Dr. M'Dowell.*—See the "North American Medico-Chirurgical Review" for November 1860, p. 1045.

[2] *M'Dowell's cases published by Lizars.*—See the "Edinburgh Medical and Surgical Journal" for October 1824, p. 249, *sqq.*

Speedily there sprang up, and was long continued in the Edinburgh Medical School and elsewhere, a violent and virulent discussion, as to the legality and propriety of the operation. Mr. Liston, at that time a contemporary Lecturer in Edinburgh with Mr. Lizars, denounced—like most others—the operation, in terms very analogous to those of Gourmelen against the ligature of arteries. He deemed the "perpetrator" of the operation "indictable for culpable homicide," and qualified "for such punishment as his rash and reckless conduct richly deserved." "It is not easy to conceive," continues Mr. Liston, "how the proposal could have been seriously entertained by any *sane* individual, far less put in practice;"

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[1] *Lizars.*—See his "Observations on the Extraction of Diseased Ovaria," Edinburgh, 1825.

and he deemed any repetition of the operation "unpardonable."[1] The language of Mr. Syme was equally decided, though not equally denunciatory; and he argued, both on theoretical and practical grounds, against ovariotomy, holding that "it would be very unjustifiable to repeat such hazardous experiments, since it is evident that, for every life prolonged by them, many must be sacrificed."[2]

Strong words and strong statements, however, very often—in this as in other instances in surgery—have betrayed great strength of prejudice rather than great strength of judgment.

With his far-seeing and practical eye, that profound and philosophic surgeon, John Hunter, perceived—in the last century—both the propriety and the practicability of ovariotomy;[3] and almost all those living and leading surgeons in Britain, who were most strenuously opposed to it a few years ago, now acknowledge that it is an operation both justifiable, and, on the whole, wonderfully successful. Mr. Syme, for instance, instead of declaring ovariotomy, as formerly, to be "very unjustifiable," now looks upon it as an operation "established in practice."[1]

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[1] *Liston.*—See his "Elements of Surgery," Part III., 1832, p. 54.

[2] *Syme.*—See his "Principles of Surgery," 3d edit., 1842, p. 419.

[3] *John Hunter.*—See his "Works," edited by Mr. Palmer vol. i. p. 573.

In the same way Professor Fergusson of London, formerly a teacher of surgery in the Edinburgh Medical School, most honourably avowed, several years ago:—"Though prejudiced against it [ovariotomy] in my early education, I now feel bound to state that the removal of such formidable disease, by one or other of the various proceedings, as first executed in this country by Mr. Lizars, and now practised by Dr. Clay, Dr. F. Bird, Mr. I. B. Brown, Mr. Walne, and others, is not only justifiable, but in reality, in happily-selected cases, an admirable proceeding."[2]

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[1] *Syme.*—See his "Principles of Surgery," 5th edit., 1863, p. 462.

[2] *Fergusson.*—See his "System of Practical Surgery," 4th edit., 1857, p. 781.

My excellent colleague, the Professor of Surgery in the University of Edinburgh, Mr. Spence, now deems the performance of the operation, in proper cases, as not only warrantable but imperative,[1] though several years ago[2] he refused to perform the operation in what was considered a favourable case, because he then thought that there were circumstances altogether adverse to the regular admission of this operation into surgery.[3]

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[1] *Spence.*—See the "Edinburgh Medical Journal" for October 1863, p. 369.

[2] *Spence.*—See the "Monthly Journal of Medical Science," January 1846, p. 65.

[3] *Ovariotomy in the Parisian Medical School.*—Some of the leading surgeons and physicians of Paris spoke out a few years ago as loudly against ovariotomy as those of Edinburgh formerly did. —(See extracts of their opinions in the "British Medical Journal" for Jauuary 18th, 1862, p. 69.) "The extirpation of diseased ovaries is," according to M. Velpeau, "a frightful operation, which ought to be proscribed, even if all the cures reported were actually true." "Spite of all statistics, we reject," says M. Huguier, "the operation almost absolutely." "For myself," observed Professor Moreau, "I consider that this operation should be classed amongst those which belong to the province of the executioner." "There is no cure," remarks Professor Cruveilhier, "of multilocular cysts, because none other than extirpation is possible. Although this operation has been practised in England and America with success, I consider that it should never be

Ample experience has latterly proved that the exposure of the abdominal cavity, and the removal of ovarian tumours, even when morbidly adherent, have no such perilous results as prejudice and false reasoning formerly led surgeons to anticipate. We have already seen (*ante*, p. 380), that the common larger amputations of the limbs are still fatal in the proportion of nearly 1 in every 3 of those operated upon. The experience of those surgeons who have each performed ovariotomy,

admitted here." M. Malgaigne declared against the operation, as "of a kind to put the woman too surely beyond the chance of any relapse." He deemed, in other words, an operation which radically cures and saves about two in every three—in a disease otherwise entirely beyond the pale of medicine and surgery — as perfectly unjustifiable; whilst amputation of the limbs — an operation sometimes performed for expediency, and for morbid states curable by other means—destroys, according to his own Parisian statistics, nearly one in every two, and yet is perfectly justifiable. That better and sounder opinions are springing up in the French Medical School, is probably indicated by the fact of so very sagacious and distinguished a representative of Parisian surgery as Professor Nélaton, having as lately as 1862 declared his opinion to the Parisian Imperial Academy of Medicine, that ovariotomy will speedily extend into French practice.—(See the "Bulletins de l'Académie Impériale de Médecine" for 24th June 1862, p. 948.)

as Dr. Clay, Dr. Atlee, Mr. Spencer Wells, Mr. Baker Brown, Dr. Tyler Smith, Dr. Thomas Keith, Dr. Grimsdale, etc., in numerous cases, has shewn, on the whole, nearly a similar resulting mortality of about 1 in 3 for that operation.[1]

As far as concerns the mere surgery of ovariotomy, the principal hope, perhaps, of increasing its safety, and of diminishing its mortality, consists of some better management of the pedicle of the tumour. It has been divided successfully in America by the écraseur by Drs. Atlee and Pope; and this plan would be the simplest and best of all, if it could be depended upon. But few operators seem to think that this measure affords a sufficient guarantee against fatal hæmorrhage. The proposed ligature of the orifice of the individual bleeding vessels can scarcely be accomplished in most instances, in consequence of too much blood being liable to escape into the pelvic or abdominal cavity during the attempt. In very many cases the pedicle has been transfixed with a needle and strong cord, and tied tightly in one, two, or more divisions, before the ovarian mass was excised. Sometimes the stump of the deligated and divided pedicle has been subsequently fixed, by needles or ligatures, between the lips of the lower part of the abdominal wound. But far more frequently it has been allowed to slip back into position, either with the ligatures cut short off; or, as is most usual, with the ends of them brought out through the lower extremity of the wound. Either of the two last proceedings involves danger to the patient, from the presence of the ligature for two or three weeks, or even permanently, as a foreign body, in the cavity of the peritoneum; and still more from disorganisation of the stump of the pedicle, in consequence of the strong and generally destructive compression to which its structures are subjected by the ligature.

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[1] *Mortality from ovariotomy.*—Dr. Churchill gives the statistical results of 249 cases of ovariotomy performed up to August 1863, by four gentlemen—namely, Dr. Clay, Dr. Tyler Smith, Mr. Baker Brown, and Mr. Spencer Wells—and he concludes as follows:—"In the practice of these distinguished men, upon whose accuracy one can rely, we have in 249 cases, 164 recoveries and 85 deaths, or rather more than one in three."—(See Dr. Churchill's "Diseases of Women," 5th edit., p. 529.) See also the statistics of the operation in Dr. Graily Hewitt's late excellent work on "The Diseases of Women," pp. 588 and 589.

The happy idea of Mr. Hutchinson, of compressing the pedicle with a clamp (see woodcut Fig. 34), which—after the removal of the tumour—is laid externally upon the outer surface of the wound, has been found to answer admirably in a great number of instances; and probably will continue to be the means most commonly resorted to. But occasionally the pedicle is so short that the clamp cannot be employed, without dangerous straining and dragging, which may sometimes endanger the life of the patient, in the same way

Fig. 34.

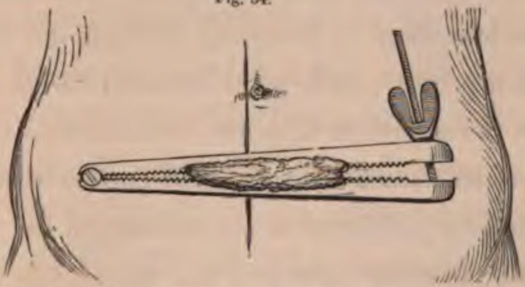

Fig. 34. Sketch of the clamp in ovariotomy, showing the mode in which it compresses and secures the pedicle of the ovarian tumour, and the position in which the clamp and pedicle are usually placed when the operation is completed. (Spencer Wells.)

as a piece of strangulated omental hernia does. Besides, the pedicle when clamped and pulled out externally, prevents, by its presence, the lower part of the wound from healing, till the clamp is removed, and the pedicle retracts. The clamp is sometimes long in sloughing through the strangulated pedicle; and, when removed early—that is, on the second or third day—the pedicle is apt to become retracted with a small portion of strangulated and half-dead tissue attached to it.[1]

Mr. Dix has proposed the use of his wire-compress, stating that "it will probably be found that the pedicle in ovariotomy may be conveniently dealt with by this method, the arteries being secured individually, and the entire stump also fixed to the abdominal wall by another wire."[2] In the "Medical Times" for March 24th 1860,

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[1] *Detachment of clamp.*—In one case of ovariotomy I left the clamp on till it separated on the twelfth or thirteenth day after the operation. My patient made a perfect recovery; but from the long detention of the pedicle between the lips of the abdominal incision, there was left an umbilical-like depression, which was long of healing.

[2] *Dix.*—See his paper on the wire-compress in the "Edinburgh Medical Journal" for September 1864, p. 216.

p. 285, I described, somewhat more in detail, the suggestion previously made (see *ante*, p. 412), of a long and strong acupressure needle or needles effecting in the same way the same object; the needle or needles, before the pedicle is divided, being first passed from without inwards through the abdominal wall, and through one margin of the pedicle, and — after crossing and bridging over nearly the whole breadth of the pedicle —being made, secondly, to pass through its other margin and the contiguous abdominal wall from within outwards. Thus, the two extremities of the needle—its blunt and sharp ends—would both appear externally, as represented in the woodcut, Fig. 35,

Fig. 35.

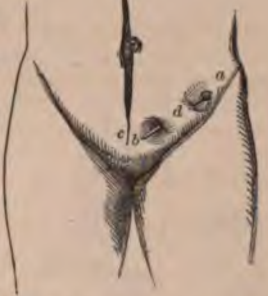

Fig. 35. Sketch showing the manner in which the acupressure-needle appears externally, when employed to compress and secure internally the pedicle of an excised ovary; *a*, the head, and *b*, the point of the long acupressure-needle used; *d*, the included portion of abdominal wall, etc., upon which a pad or bolster could be placed externally, and stronger pressure applied, if necessary, by a thread or wire twisted crosswise round the exposed ends of the needle; *c*, *c*, the extremities of the abdominal wound for the removal of the ovary.

The pedicle and its contained vessels could thus internally be pinned and compressed between the needle and the abdominal parietes, with a degree of force which could be increased, if necessary, by placing a pad or compress upon the skin outside (at *d*, Fig. 35), between the two emerged ends of the needle, and applying pressure upon it there, by ligatures drawn round these needle-ends. The needle or needles could, of course, be removed at will in one or two days; or when the occlusion of the vessels was deemed complete. In this way no ligature or other foreign body would be left between the lips of the abdominal wound, so as to prevent its complete closure by primary union. The accompanying rough diagram (see woodcut,

Fig. 36.

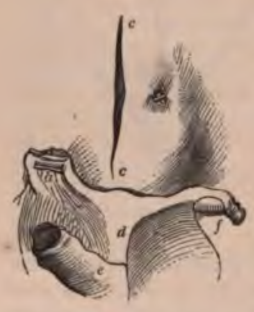

Fig. 36. Diagram of a supposititious internal view of the posterior surface of the anterior abdominal walls after ovariotomy, with the stem of a long acupressure-needle (*a*) passing across the stump (*b*) of the left excised ovary, and compressing it against the adjoining abdominal walls; *c c*, the extremities of the incision through the abdominal walls; *d*, the uterus; *e*, the rectum; *f*, the right ovary.

Fig. 36) is given as an internal view of this proposed mode of dealing with the pedicle.

There is the same objection to this method, as to that of the wire-compress, that it keeps the pedicle fixed, and generally more or less dragged. It is possible that the objection might be, in a great measure, overcome, if a successful means could be devised of transfixing the pedicle or its individual vessels with an acupressure needle or needles, and then compressing and closing them by a half or by a complete rotation of the tissue of the pedicle (as described in Chapter XVIII.), before or after the stalk was divided. The sharp end of the needle or needles could be fixed by being pushed onwards into the muscular tissue of the lateral or posterior portion of the pelvis; and iron-threads attached to their eye-ends would allow of their withdrawal in two or three days. In the following case acupressure was successfully applied to the pedicle of an ovarian tumour, in a different way.

Case XXXIX.—*Ovariotomy—Acupressure applied to the Stalk, and removed in Forty-six*

Hours.—The patient was married, the mother of one child, and had been three times tapped. The multilocular ovarian tumour weighed upwards of 30 lbs. The largest cyst contained 23 lbs. of pure pus. The tumour was universally adherent, in front, to the abdominal walls. After I had detached it and drawn it out externally, I applied a clamp to the ovarian stalk so near the tumour as to include a portion of it. When the tumour was removed, the uterus and attached parts showed a strong tendency to pull the clamp downwards into the pelvic brim. It was evident that it could not be left on without great and inevitable dragging upon the pedicle. I then passed a glass-headed needle (see it represented at *c*, in woodcut, Fig. 39) twice through the ovarian stalk, immediately below the clamp. In passing it thus twice, I left out at either side a portion of tissue, to which no compression was applied, with the hope that these two lateral portions would supply with blood and vitality the strangulated stump of the ovarian pedicle. To compress the stalk sufficiently, I threw over the point-end of the needle a loop of strong tinned iron-wire, of the size described by iron-workers as No. 22 (see Fig. 39, *b*, *b*, *b*); twisted it half round the beaded end of the acupressure-needle; and after drawing it with great tightness to prevent any discharge of blood from the included vessels, I fixed it by giving it an additional twist round the needle. The needle was thus placed under nearly the same conditions as in the method of acupressure previously described and delineated as No. 3 (p. 60). Next, in order to prevent any injury or lesion from the sharp end of the needle, a slender hollowed iron hood (see woodcut, Fig. 38), three-quarters of an inch in length, was placed over it; and this hood was fixed to the twisted portion of the

Fig. 37.

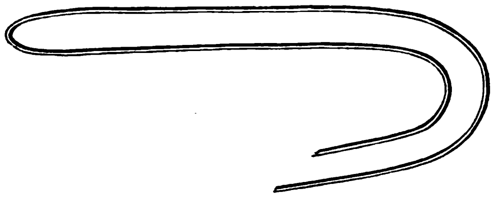

Fig. 37. Loop of strongish wire for compressing the pedicle of the ovary. A portion of the loop only is represented.

Fig. 38.

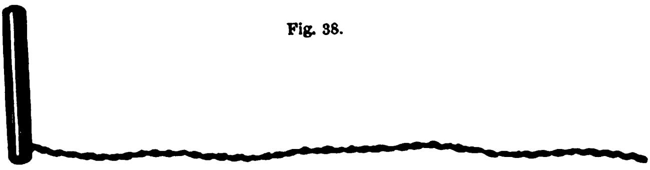

Fig. 38. Hollow hood and attached wire, to pass over and protect the point of the acupressure-pin in ovariotomy.

strong compressing wire at the head-end of the acupressure-needle by a duplicature or two of slender suture-wire of the size No. 32. The clamp was then removed; the small remaining portion of the tumour which it embraced was clipped off; and the acupressure-needle was carefully placed across the brim of the pelvis. A string attached to the beaded head of the needle, and the wires used in compressing the stalk, were left out at the lower edge of the abdominal wound. The wound itself was united by stitches of iron thread, passed so as to embrace the peritoneum, except in one instance, where the stitch was only superficial. The wire-threads were carefully moulded to the exact shape of the parts in which they were each respectively placed, by pressing each in succession, after it was tied, with two fingers simultaneously—one applied inside and one out. The little acupressure apparatus is represented, exactly as it came off, in Fig. 39, and was removed in forty-six hours by merely pulling at the head of the acupressure pin. The two sets of wires, namely the loop of strong wire, which compressed the pedicle, and the slender wire which carried the hood, came out with it. Four days after the operation, all the deep iron stitches, without a drop of pus following any of them, were removed, and the wound was found healed from end to end by the first intention. The superficial iron stitch was left in a few days longer, and two or three drops of pus followed its withdrawal. Thirteen days after the operation, the cicatrix at its uppermost end opened under a fit of coughing, and a quantity of pus which had been forming a small swelling there for a few days, escaped. In this instance, there existed before the operation the purulent diathesis in the most marked form;

Fig. 39.

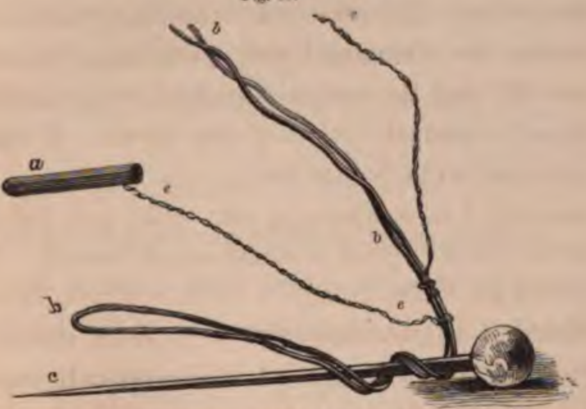

Fig. 39. Acupressure apparatus sketched of its actual size after its removal. *a*, The small cylindrical or hollow hood that covered the sharp end, *c*, of the acupressure needle; *b*, *b*, *b*, the loop of strong wire which compressed the ovarian pedicle against the needle. The external continuation of this piece or portion of looped wire, is here represented as bent up to save space in the diagram, and is surrounded by the slender wire *e*, *e*, *e*, of the hollow hood *a*.

the patient's pulse was never for weeks under 100, and usually considerably higher; and there was a purulent collection of 23 lbs. of matter within her body. After the small abscess within and behind the abdominal wall gave way, the pulse sunk towards the natural standard, and the patient rapidly regained her usual health and strength; and remains perfectly well.

In managing the acupressure apparatus in the preceding case, the large glass head of the pin offered a slight impediment to its withdrawal. The size of the glass head necessitated the opening up of the lower edge of the wound to the extent of a line or two more than otherwise was necessary. I believe a needle of the same shape and size, having a large eye, and a loop and string of strong wire passed through it, would be found to be more commodious. Such a needle is represented in the accompanying woodcut, Fig. 40. For broader pedicles a longer one would be necessary. I have stated above, that in order to withdraw the acupressure apparatus represented in Fig. 39, I left a string affixed to the beaded end of the needle, the loose extremity of the string passing out through the wound externally. The thick thread of wire, attached to the eye-end of the needle, in Fig. 40, will answer this purpose better.

Fig. 40.

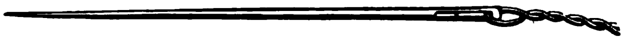

Fig. 40. Form and size of needle for acupressing the stalk of an ovarian pedicle. The eye-end of the needle may for the purpose be formed of glass, as in Fig. 39, or left as represented here, with a common eye, through which a circle of strong wire is passed. This wire-thread should, of course, be three or four inches long, and is represented curtailed.

Probably it may turn out, that allowing the tied ovarian pedicle to pass back into its normal situation under the compression of an acupressure-needle, and removing that needle in a day or two after its application, will diminish the risks and mortality attendant upon ovariotomy. I am the more inclined to take this view from seeing it stated, in the last edition of Dr. Churchill's very able work on the Diseases of Women, that my friend, Dr. Tyler Smith of London, has only lost three out of eighteen cases of ovariotomy;[1] and the principal peculiarity, I believe, in Dr. Smith's mode of operating, consists in allowing the stalk of the tumour, tied with an organic ligature of silk or cord cut off short, to slip back at once into the cavity of the abdomen. In this method we encounter the dangers occurring from a foreign body, such as a ligature, being left permanently within the cavity of the abdomen; and from the tied end of the stalk being liable to be disorganised by that ligature. By acupressure we avoid both of these dangers.

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[1] *Churchill.*—See his work on the "Diseases of Women," 5th edit., p. 529.

CHAPTER XXIII.

TABULATED CONTRAST BETWEEN LIGATURE AND ACUPRESSURE.

IN closing this essay, I shall only further try to present, in a tabulated form, a summary, as it were, of the leading differences and distinctions between the ligature and acupressure, and their respective consequences and effects, which we have attempted to trace out in some of the preceding pages.

COMPARISON BETWEEN THE LIGATURE AND ACUPRESSURE.

THE LIGATURE	*ACUPRESSURE*
1. Requires isolation, and consequently some detachment, of the end of the vessel from its vital organic connections.	1. Requires none.
2. Produces direct mechanical injury, bruising, and laceration of the two internal coats of the artery.	2. Produces none.

THE LIGATURE	*ACUPRESSURE*
3. Produces strangulation of the external coat.	**3. Produces none.**
4. Leads on, inevitably, to ulceration or molecular destruction of the external coat at the constricted part.	**4. Produces none.**
5. Causes mortification of the artery at the tied point, and usually also below it.	**5. Produces none.**
6. Produces, consequently, as many sites of ulceration and suppuration, and as many dead decomposing sloughs in each wound, as there are arteries ligatured in that wound.	**6. Produces none.**
7. If organic, as of silk or hemp, it imbibes animal fluids, which speedily decompose, and irritate the surrounding living structures.	**7. Requires only impervious metallic needles or threads, which are incapable of imbibing animal fluids.**
8. Requires to produce the three highest stages of inflammation at each ligatured point—viz. ulceration, suppuration, and mortification.	**8. Requires to produce inflammation up to the stage of adhesion only.**
9. Is not removable except by the slow ulceration and sloughing of the ligatured vessel, and requires a period of from four or five to twenty days or more for its separation.	**9. Is removable in an hour or two, or in one, two, or three days, at the will of the operator.**
10. Stops only the artery tied.	**10. Stops generally both artery and vein.**

THE LIGATURE	*ACUPRESSURE*
11. Stops only one artery.	11. May close two or more smaller arteries by means of a single needle.
12. Generally requires two persons for its application.	12. Requires only one person.
13. Is sometimes followed by secondary hæmorrhage, as an effect of ulceration and sloughing.	13. Is seldom followed by secondary hæmorrhage from ulceration or sloughing, as it produces none.
14. Sometimes fails altogether in cases of recurring secondary hæmorrhage.	14. Has succeeded under such circumstances where the ligature has failed.
15. Sometimes cannot be applied till the surgeon first exposes the bleeding vessel by dissection with the knife, as in vessels retracted in amputations, in wounds of the wrist, etc.	15. Does not necessarily require the exposure of the vessel, and, therefore, often prevents the necessity for antecedent dissection by the knife.
16. Prevents, as a foreign body, adhesion of the sides and lips of the wound by first intention, in the course of its track, as long as it remains.	16. Is early withdrawn, and is hence far less opposed to primary union.
17. Is apt, as an irritant body, to disturb and upset the process of primary adhesion in its vicinity.	17. Is early withdrawn, and has no irritant effect.
18. Unavoidably creates within the depths of the wound, pus, sloughs, and putrid materials, which are locked up and applied to the imbibing or absorbing cut surfaces of the wound.	18. Does not create nor apply any dangerous putrefying materials to the fresh absorbing surface of the wound.

THE LIGATURE	*ACUPRESSURE*
19. Places the wound therefore in very dangerous local hygienic conditions.	19. Places the wound locally in far healthier hygienic conditions.
20. Is not unfrequently followed by surgical fever, from its leading to the formation and absorption of septic matters from the surface of the wound.	20. Is much less likely to be followed by surgical fever, because it does not lead to the formation of septic matter, and closes the veins as well as the arteries.
21. For these various reasons it makes primary union rarer, healing slower, and septic or surgical fever more frequent.	21. For these reasons it makes complete primary union more frequent, healing quicker, and septic or surgical fever less common.

The preceding comparison might, if it were necessary, be made even longer; but it refers, as I have said, to the leading differences and distinctions only, between the ligature and acupressure. The table, as a picture of contrasts, requires no comment. It speaks sufficiently for itself.

Of the objectionable and deleterious effects of the ligature, such as are portrayed in the preceding table, surgeons will perhaps, in after times, discourse as earnestly and eloquently as surgeons, in these times, now write of the dangers and horrors of the actual cautery; for, of the ultimate general abandonment of the deligation of arteries in wounds I have no doubt, though, at the same time, of its speedy abandonment I have no great hopes. The histories which we have traced, in some of the preceding chapters, of the long and bitter opposition to the introduction of the ligature, and to the introduction of the healing of wounds by first intention, too strongly prove the painful and protracted slowness with which all revolutions in surgery are accomplished, particularly when these revolutions require—like acupressure—both some amount of pathological reasoning, and some amount of practical experience to confirm and establish them.

When the change aimed at is one that—like the operation of anæsthetics—can be demonstrated by a simple appeal to the *direct* evidence of the senses, the result is more swift and sure. A most eminent and erudite surgical author—one indeed who has few or no compeers in the past or present history of surgical literature—when discussing the possibility of modifying or eschewing pain in surgical operations, tells us :—"We every day see individuals [who are being operated on] praying in mercy that we would stop, that we would finish, thus imploring and menacing us, and who would not fail to escape if they were not firmly secured;" and "in former times surgeons made use," he observes, "of cords, straps, and machines, to control the movements of the patient during operations." He further discusses the question, whether dipping the scalpel in oil, or in cerate, or in hot water, enables the cut to be made with less torture to the poor agonized patient.[1] But, he continues, "a cutting instrument, and pain in operative surgery, are two words which are never presented separately to the mind of the patient." And he adds, as an incontrovertible dogma, that "*to avoid pain in operations is a* CHIMERA *that we can no longer pursue in our time.*"

The great surgical author whose words I quote, is that Nestor of European surgeons, Professor

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[1] *Torture to the poor agonized patient.*—See Appendix No. IX. on the abolition of pain from a patient's point of view.

Velpeau[1] of Paris, who published the remarks I have just cited, in his " Médecine Opératoire," written some twenty or thirty years ago. He has happily lived to see his own prophecy on this matter utterly and entirely confuted; and few surgeons have welcomed with greater enthusiasm and generosity than himself, the sudden arrival of the happy era of the abolition of human pain and human suffering in surgical operations.

Though no surgeon, and no prophet, I venture, like M. Velpeau, upon a prediction, and it is to this effect: that—within the next two or three generations—operators will have ceased to implant systematically, with arterial ligatures, small dead sloughs and irritating setons into the depths and upon the sides of every bleeding wound,—and will, on the other hand, acting on the principle of metallic compression, arrest their hæmorrhages by acupressure in some of its discovered or discoverable modifications,—or, it may be, by some other hæmostatic means even still more safe and simple. It is mere idleness and frivolity to argue, as has been lately and earnestly done, that no efforts should be made in this direction, because surgeons are generally quite content with the ligature, in despite of its evils, and have no wish to change. But, as a practical science, surgery *must* ever march forwards—it can acknowledge no boundaries to its onward progress and development—and knows of no finality.

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[1] *Velpeau.*—See the American translation of Velpeau's " Elements of Operative Surgery," 1851, from the Paris edition of the work of 1839, vol. i. pp. 20 and 24.

APPENDIX.

APPENDIX.

No. I.

See Page 47.

ON THE TOLERANCE AND NON-TOLERANCE OF THE LIVING TISSUES FOR VARIOUS FOREIGN BODIES.

IN surgical pathology there are some interesting and important general laws referring to the relation of living structures to the presence of foreign bodies placed or embedded within them. These laws have hitherto attracted little or nothing of the attention of systematic writers on surgery. Yet they seem to me to be of no small practical moment in reference to various questions in surgical science. I refer particularly to the comparative passiveness and tolerance of living tissues for the presence and contact of metallic materials; and their excitability, and irritation, on the other hand, under the presence and contact of foreign organic bodies derived from the vegetable or animal kingdoms. Let us first consider these points.

SECTION I.—*Law of Tolerance of Living Structures for the Presence of Foreign Metallic Bodies.*

Metallic bodies, when lodged and embedded without much mechanical contusion or injury in living tissues, produce comparatively little or no irritation by their presence; and if inflammation is excited by their contact, that inflammation is usually limited to the first or adhesive stage, unless the contact at any point or points is so excessive as to produce ulceration by the mere effect of morbid pressure (see *ante*, p. 103). In corroboration of this important general law, let me adduce some evidence (1) from experiments on the lower animals; and (2) from observations on the human subject.

Experiments on the Lower Animals.—In the lower animals, when a portion of metal is placed in the subcutaneous tissues, and the external wound is closed over it, the foreign body becomes embedded and fixed in its site, without leading to the production of suppuration and ulceration in the tissues in contact with it. With a view of testing this fact, small pieces of gold, silver, copper, lead, and iron were placed deeply in the back and sides of pigs. The experiments were made for me by Mr. Edwards and Dr. Jardine Murray. We found no pus effused around these metallic bodies, when the wounds were opened and carefully examined several days subsequently. Around the pieces of gold, lead, and copper there was a thickish layer of coagulable lymph or fibrine, making as it were a complete cast or mould of the foreign body; but showing under the microscope nothing but exudation corpuscles and granules. Around the pieces of silver and iron there was no such distinct appearance of an incipient cyst; for the portions of metal seemed to be closely embraced by the surrounding tissues, with little or no adhesive exudation between their contiguous surfaces. This experiment was several times repeated on other swine, with the same general results. We found, in one case, a cyst formed around an angulated piece of bright steel.

In some experiments which Mr. Syme made several years ago upon the dog—with the view of ascertaining whether or not the periosteum could throw out bone upon its internal surface—he introduced between the radius and its periosteum a thin plate of metal, using, I believe, lead for the purpose; and the superficial parts were found to heal "kindly" over and around this foreign body, apparently without any tendency whatever to suppuration or ulceration. He exposed the radius in another experiment, cut away the periosteum, and surrounded the denuded bone with a piece of metal. At the end of six weeks he found a thick, tough capsule formed, enclosing the metallic plate.[1]

But the law holds equally good that metallic substances may be lodged within the living tissues of the human body without creating any considerable amount of irritative reaction, and without exciting by their presence any other than *mechanical* inconveniences and disturbances.

Observations on the Human Subject.—It is a well-known fact in military surgery that in gunshot wounds, after the immediate effects, in the way of contusion and injury, resulting from the mechanical force of the ball, have passed away, the metallic ball itself may lodge in the tissues of the body for months or years with impunity; more especially if the internal vital organs are not touched by it. And sometimes balls have been found lodged for months or years even in the vital organs themselves, as the heart and brain.[1]

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[1] *Syme.*—"Transactions of the Royal Society of Edinburgh" for 1840, vol. xiv, p. 162.

In the course of my inquiries I have had reported to me, by my medical and other friends, several instances in which bullets have remained lodged within the bodies of officers and soldiers still living, and who received them at Waterloo and in the Peninsular War, between forty and fifty years ago, and upwards.[2] Ambrose Paré, when speaking on this subject long ago, remarked :—"Leaden bullets lye in some parts of the body some whiles seaven, eight, or more yeares, so that they neither hinder the agglutination of the wound, neither doth any other symptome happen thereupon, as I have diverse times observed; untill at length by the strength of nature forcing them, and their proper weightines bearing them downewards, they shew themselves in some lower part, by their swelling or bunching forth, and so must be taken forth by the hand of the Chirurgion. For they say Lead hath a certaine sympathy and familiarity with mans body, chiefely the fleshy parts thereof. Wherefore it neither putrefies its selfe nor causeth the flesh to putrefie; besides it hath an excellent faculty in cicatrizing old ulcers."[1]

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[1] *Bullets occasionally remaining for years buried in vital organs.*—Sometimes "balls," observes Professor Traill, "have been lodged in various parts of the body, even in the chest, or the heart itself, for years, without causing death."—("Outlines of Medical Jurisprudence," 3d edit., p. 88.) Dr. Balch has lately recorded a case in which a leaden bullet remained embedded in the walls of the right ventricle of the heart for twenty years. Six weeks after the wound the wounded man resumed his usual work.—(See the "American Journal of the Medical Sciences" for July 1861, p. 293.) For various instances of bullets and metallic fragments remaining within the encephalon or in the brain itself, see M. Quesnay's essay on "Wounds of the Brain," in the "Mémoires de l'Académie Royale de Chirurgie," Paris, 1743, tom. i., partie ii., pp. 131-135. M. Malle cites the case of an officer wounded at Wagram, who attained a very advanced age, and after death they found in him a ball lying in the left lobe of the brain.—(See Appia's "Ambulance-Surgeon," English edit., p. 53.)

[2] *Instances of balls long lodged within the body.*—Mr. Guthrie describes, in his Commentaries on Surgery, the very dangerous ball-wound which the late Duke of Richmond received through the chest at the battle of Orthez in 1814.—(See his "Commentaries on the Surgery of the War," etc., 5th edit., p. 448, *sqq.*) The ball remained lodged in the posterior walls of the chest till the Duke's death, in 1860, or for nearly half a century, and without interfering with his health. Dr. Smith has related to me the case of General Miller, who was struck with three balls

The celebrated John Hunter, in his essay on gunshot wounds, when discussing the practice of leaving the ball, and not dilating the gunshot wound on its account, observes to the same effect, "This practice has arisen from experience; for it was found that balls,

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at the taking of Pisco in 1819, and was wounded by a fourth at Chiloe, some months afterwards. Subsequently he led a very active military life, and died in 1861. On embalming his body, two of the bullets were found still lodged in it. At the Hotel des Invalides, in Paris, "we have still," writes M. Hutin, "two or three soldiers of the first empire who carry about balls which struck them thirty-five years ago. They are very often incommoded by them; but as they lie very deep, one does not dream of extracting them." — (See Appia's "Ambulance-Surgeon," p. 53.)

[1] *Ambrose Paré.*—See the English edition of his "Workes," p. 429.

when obliged to be left, seldom or ever did any harm when at rest, and when not in a vital part; for balls have been known to lie in the body for years, and are often never found at all, and yet the person has found no inconvenience. This knowledge of the want of power in balls to promote inflammation when left in the body arose from the difficulty of finding them, or extracting them when found, and therefore in many cases they were obliged to leave them."[1]

It would be easy to adduce evidence of the same kind from the works of other and later military surgeons, as John Bell,[2] Guthrie,[3] Bransby Cooper,[4] etc., but additional proof is perhaps superfluous, as the fact is one generally acknowledged in surgical pathology.

Seeing thus that musket-balls may remain lodged without irritation or inconvenience, in contact with the structures of the living body, it is scarcely necessary to add—what the experience of almost every surgeon can corroborate—that leaden pellets and small shot do often in the same way lie embedded for years beneath the skin, or more deeply in the living structures.

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[1] *John Hunter.*—Palmer's edition of his "Works," vol. iii. p. 555.

[2] *John Bell.*—"Discourses on the Nature and Cure of Wounds," 3d edit., p. 206. A ball, says Mr. Bell, "often lies, without danger, buried in the flesh for years or for life."

[3] *Guthrie.*—"Treatise on Gunshot Wounds," 1820. "When," Mr. Guthrie remarks, "a ball has been lodged for years, we find that a membranous kind of sac is formed around it, which shuts it in as it were from all communication with the surrounding parts, and in some instances it seems to do so, and the patient suffers no sort of inconvenience from its retention," p. 96.

[4] *B. Cooper.*—"Principles and Practice of Surgery," p. 98. "It is not," Mr. Cooper observes, "a matter of so much importance as might be supposed, that the ball should be extracted, as there are very many instances of persons in whom a ball has remained without producing any ill effect by its presence."

In these cases of leaden bullets and pellets lodged for any length of time, the surrounding soft tissues, or a special cyst, embrace and hold firm the enclosed foreign body. "When," observes Mr. Guthrie, "a ball has been lodged for years, a membranous kind of sac is formed around it, which shuts it in, as it were, from all communication with the surrounding parts. If it should become necessary to extract a ball which has been lodged in this manner, the membranous sac will often be found to adhere so strongly to the ball that it cannot be got out without great difficulty, and sometimes not without cutting out a portion of the adhering sac."[1] In an old patient, who had been affected more than once with syphilis, Morgagni found on dissection a leaden pistol-bullet, which had been lodged in his thigh thirty years before death. There was, he adds, a cyst or "membranous follicle about that bullet, with which it was streightly inclos'd all round."[2]

Flat pieces of lead may lie embedded in the tissues of the human body, with apparently similar impunity to round bullets and pellets. Mr. Samuel Cooper quotes a remarkable example of this kind from M. Bordier. The case occurred at Pondicherry:—"An Indian soldier," says Mr. Cooper, "angry with his wife, killed her, and attempted to destroy himself by giving himself a wound with a broad kind of dagger in the abdomen, so as to cause a protrusion of the bowels. A doctor of the country being sent for, dissected between the muscles and skin, and introduced a thin piece of lead, which kept up the bowels. The wound soon healed up, the lead having produced no inconvenience. The man was afterwards hanged, and M. Bordier, when the body was opened, assured himself more particularly of the fact."[1]

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[1] *Guthrie.*—"Commentaries on the Surgery of the War," etc., 5th edit., p. 34.

[2] *Morgagni.*—"Seats and Causes of Diseases," Alexander's Translation, vol. i. p. 862.

The instances which I have already cited refer chiefly to *lead*, or lead and some of its alloys, lying in contact with the living tissues. And some authors, indeed, imagine that this negative property of harmlessness belongs, among the metals, to lead alone. "Bullets of stone," remarks Ambrose Paré,[2] "iron, and of any other mettall than lead, are of another nature, for they cannot remaine any long time in the body without hurt; for iron will grow rusty, and so corrode the neighbouring bodyes, and bring other maligne symptomes." But the evidence of other metals than lead remaining harmlessly embedded in living tissues, or passing harmlessly through them, is equally strong. Steel needles, for example, may, as is well known to surgeons, long remain embedded in the living tissues with little or no inconvenience. Needles embedded in different parts of the body and extremities, are not unfrequently met with in the dissecting-room, when every spot is subjected to the searching knife of the medical student. Even when in the living body, needles travel about from part to part, from pressure of the muscles, etc., acting mechanically on one or other of their extremities, they produce little irritation in the course of their transit. If foreign bodies, says John Hunter, "are such as can be made to change their situation by the actions of the body upon them, as pins or needles—or from gravity, as is the case sometimes with bullets—then the parts through which they pass seem not to be much altered or disturbed."[1]

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[1] *Samuel Cooper.*—"Surgical Dictionary," 7th edit., p. 611; and "Journal de Médecine," vol. xxvi. p. 538.

Parè.—"Workes," p. 429.

Various other metals, or combinations of metals, besides lead and iron, possess the same negative property of harmlessness; and, indeed, this principle has been taken advantage of in the religious and other rites of some nations. Thus the Rev. Howard Malcolm, in his account of the religion of the Burmese, states: "Amulets and charms are worn by both sexes, but not by a large number as among Hindus. One of these, common among military men, is the insertion of pieces of gold or other metal, under the skin of the arm, between the elbow and shoulder. I was allowed," Mr. Malcolm adds, "by one of the Christians at Ava, to take from his arm several of these. They are of gold, inscribed with cabalistic letters."[2] Some of the Burmese warriors are, observes Captain Yule, in his work on Burmah,[3] said to retain the practice "of inserting a piece of metal under the flesh to make themselves invulnerable."

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[1] *J. Hunter.*—Palmer's edition of his "Works," vol. iii. p. 287

[2] *H. Malcolm.*—"Travels in South-Eastern Asia," vol. i. p. 307.

[3] *Yule.*—"Narrative of the Mission to the Court of Ava in 1855," p. 208.

Accident is frequently furnishing us with examples of the same law of tolerance of the living tissues for foreign metallic bodies—under conditions where two metals are united. For instance, our common tinned iron pins frequently enough become accidentally lodged in the external or subcutaneous tissues, or are swallowed, and then traverse different parts of the body without showing much irritation or inflammation along their track. Regarding the cattle which feed in bleaching-fields, Mr. Hunter observes, "There is not one of these killed without having their stomachs, etc., stuffed full of pins, and no seeming inconvenience takes place, for they appear to be healthy, and fatten as readily as other cattle." Among "the cases that have occurred of people swallowing pins, needles, etc.," these foreign bodies "have," says Mr. Hunter, "been found to travel almost over the whole body, without producing any effect except in some situations exciting some sensation."

Mr. Hunter, in the chapter from which I have made these quotations, is inclined to argue that the same material which will produce little or no irritation, or at the most only adhesive inflammation in the *deeper* parts of the body, will more and more readily induce suppuration as it approaches the cutaneous surface—"external parts," to use his own words, "assuming the suppurative inflammation more readily than the internal."[1] Hence, he would expect an abscess to form around a bullet, pin, or needle lodged immediately beneath the skin, although the same bodies would excite no such inflammatory reaction when they were lodged in the deeper structures of the body. But suppuration does not by any means always, or indeed frequently, attend the approach of metallic bodies to the surface. Pins, needles, and bullets are often extracted by a slight incision through the skin, without a vestige of pus being traceable around them. And when they do, as indeed sometimes happens, lead to suppuration, when lodged superficially and subcutaneously, the inflammatory or suppurative action is generally, if not always, the result of compression and damage of the soft tissues lying around the foreign body—these soft tissues being, as the foreign body approaches the external surface, always liable to be contused and injured by every form of accidental outward pressure that impinges upon that surface. In fact, in the harmlessness of acupuncture-needles, and latterly, in the perfect innocuousness of perfect metallic stitches, we have abundant evidence that metallic bodies produce, *per se*, as little irritation when lodged in the skin and mucous membrane, as they do when they are lodged in any of the deeper structures of the body. And, no doubt, Mr. Hunter[1] was far more correct when he observed, with his own wondrous sagacity, "It is probable that these cases of pins, etc., owe their want of power in producing suppuration, not entirely to situation, but, in some degree, to the nature of the substance—METALS, perhaps, not having the power of irritation [inflammation] beyond the adhesive, for when the adhesive has taken place, the part appears to be satisfied."

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[1] *Hunter.*—Palmer's edition of his "Works," vol. iii. pp. 287 and 288.

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[1] *Hunter.*—Palmer's edition of his "Works," vol. iii. p. 287.

The important practical law of the tolerance of the living tissues for metallic bodies has been observed in several remarkable cases where, in consequence of gun-explosions, considerable pieces of iron have become embedded among the bones and tissues of the face.

Fig. 41.

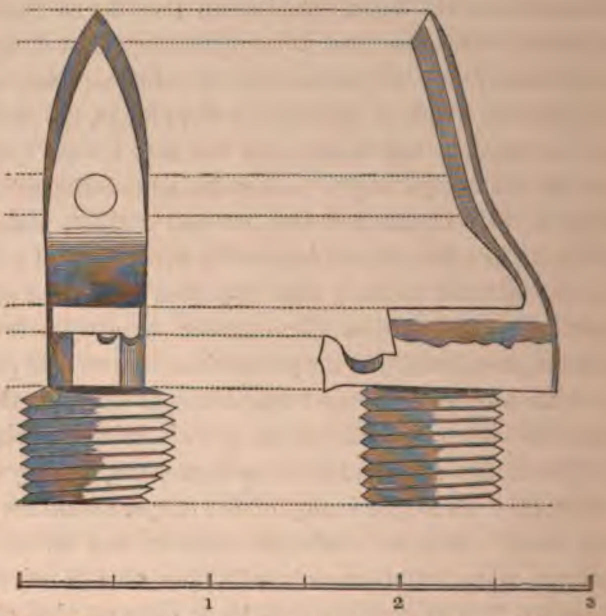

Fig. 41. Front and side views of the gun-breeching removed by Professor Keith. The gun-breeching is represented of its actual size.

The accomplished Lecturer on Clinical Surgery at Aberdeen, Dr. Keith, has lately recorded an interesting case of this kind, in which the breeching of an exploded fowling-piece was lodged for four months below the right eye and across the root of the nose. The external wound closed without the presence of the lodgment of any foreign body being suspected; and with the exception of occasional headache, the patient remained otherwise in good health. He applied to Dr Keith in consequence of being annoyed by a constant weeping from a small slit left at the root of the nose. On examination, Dr. Keith detected the metallic body and successfully removed it. It consisted of a mass of iron, two inches and a half in length, and two ounces and five drachms in weight. For the woodcut of it, Fig. 41, I am indebted to the kindness of Dr. Keith. He found the metallic mass resting against the sphenoid bone, in front of the *sella turcica*, with its screw-bolt projecting laterally into the bottom of the left orbit.[1]

Several writers have described an analogous injury in the case of Lieutenant Fretz, where the foreign body remained embedded for eight years. I shall cite the graphic account of the case, as given by my friend Sir J. Emerson Tennent, in his admirable work upon Ceylon:—

"Among extraordinary recoveries from desperate wounds, I venture to record here an instance which occurred in Ceylon to a gentleman, while engaged in the chase of elephants, and which, I apprehend, has few parallels in pathological experience. Lieutenant Gerard Fretz, of the Ceylon Rifle Regiment, whilst shooting at an elephant in the vicinity of Fort MacDonald, in Oovah, was wounded in the face by the bursting of his fowling-piece, on the 22d January 1828. He was then about thirty-two years of age. On raising him, it was found that part of the breech of the gun, and about two inches of the barrel, had been driven through the frontal sinus, at the junction of the nose and forehead. It had sunk almost perpendicularly, till the iron plate called 'the tail-pin,' by which the barrel is made fast to the stock by a screw, had descended through the palate, carrying with it the screw, one extremity of which had forced itself into the right nostril, where it was discernible externally, whilst the headed end lay in contact with his tongue. To extract the jagged mass of iron thus sunk in the ethmoidal and sphenoidal cells was found hopelessly impracticable; but, strange to tell, after the inflammation subsided, Mr. Fretz recovered rapidly, his general health was unimpaired, and he returned to his regiment with this singular appendage firmly embedded behind the bones of his face. He took his turn of duty as usual, attained the command of his company, participated in all the enjoyments of the mess-room, and died *eight years afterwards*, on the 1st of April 1836, not from any consequences of this fearful wound, but from fever and inflammation brought on by other causes. So little was he apparently inconvenienced by the presence of the strange body in his palate, that he was accustomed with his finger partially to undo the screw, which, but for its extreme length, he might altogether have withdrawn. To enable this to be done, and possibly to assist by this means the extraction of the breech itself through the original orifice (which never entirely closed), an attempt was made, in 1835, to take off a portion of the screw with a file, but, after having cut it three parts through, the operation was interrupted, chiefly owing to the carelessness and indifference of Capt. Fretz, whose death occurred before the attempt could be resumed. The piece of iron, on being removed after his decease, was found to measure 2¾ inches in length, and weighed two scruples more than two ounces and three quarters. A cast of the breech and screw now forms No. 2790, amongst the deposits in the Medical Museum of Chatham."[1]

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[1] *Keith.*—See the "Medical Times and Gazette," October 23 858, p. 416.

Fig. 42.

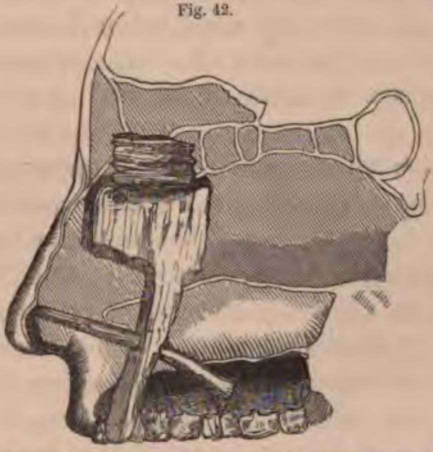

Fig. 42. Section of the head in the case of Captain Fretz, showing the position in which the gun-breeching was lodged in his case. The foreign body is of course represented much reduced in size.

[1] *Tennent.*—" Ceylon. An Account of the Island, Physical, Historical, and Topographical," 3d edit., vol. ii. p. 333. Dr. O'Callaghan states, that at the autopsy of Captain Fretz " the anterior portion of the right hemisphere of the brain rested on the flat part of the breech, which received the charge, separated from

The accompanying woodcut (Fig. 42), showing the position of the lodged foreign body in Captain Fretz's face, is copied from a short notice of the case, published by Sir George Ballingall in the "Edinburgh Medical and Surgical Journal."[1]

The facts which we have thus collated entitle us, I believe, to lay down as a logical inference from them that proposition with which we started—namely, that there exists in surgical pathology a great general principle which, some years ago, I ventured to denominate the Law of Tolerance of Living Structures for the Presence of Metallic Bodies.[2]

A writer whom we have already quoted (see *ante*, p. 49), after stating and showing that "metallic bodies of every kind may remain embedded in the animal tissues without being productive of injury," adds, as his opinion, "that the property of irritating and inflaming by mechanical contact belongs only to those bodies which are *non-conductors of electricity*."[3]

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the iron surface only by a false membrane."—(See the "Dublin Medical Press" of February 5, 1845, p. 81.) In the "Medical Times and Gazette" for August 21, 1858 (p. 183), Mr. Prescott Hewett has described Captain Fretz's case, and expressed his belief that the fluid which discharged from the nostrils was the cerebro-spinal fluid. For other analogous cases see Dr. Fraser in the "Edinburgh Medical Journal" for September 1856, p. 247; and Mr. Hughes in the "Lancet" for September 18, 1858, p. 307.

[1] *Ballingall.*—See the "Edinburgh Medical and Surgical Journal," vol. 57 (1842), p. 117.

[2] *Law of Tolerance.*—See the "Medical Times and Gazette" for June 19, 1858, p. 625.

[3] "Edinburgh Medical and Surgical Journal," vol. xxvii. p. 197.

This attempted explanation is no doubt entirely erroneous. For other inorganic bodies, besides the metals, may be lodged with impunity in living tissues; and this, too, though they are non-conductors of electricity. Small pieces of glass, for example, occasionally remain long embedded in the body in the same way as pieces of metal do. Mr. Hunter, indeed, points out this fact specially.[1] A medical friend of mine has a small piece of glass embedded in his lip, which has remained there with impunity for nearly eighteen years. Another medical friend has had two small portions of broken glass embedded for twenty-six years in the region of the tonsils, attended at times with considerable local irritation. He has stated to me an instance, where a portion of broken glass, about a quarter of an inch square, lodged below the knee, and was extracted on the opposite side of the limb three years afterwards. "There never was," he adds, "any suppuration in this case from first to last." I have heard of two or three cases of small pieces of glass lying quietly in the structures of the hand for long periods. An eminent surgeon had, for twenty or more years, a small piece of coal lying without inconvenience beneath the skin of the leg; and the minute particles of carbon left by the explosion of gunpowder and by tattooing, are well known to remain in the cutaneous tissues for a long lifetime without producing any irritation or disturbance. The Burmese, according to Mr. Malcolm, bury and carry, not only gold, but also "sometimes small gems" under the skin of their arms.[1]

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[1] *Retention of pieces of glass.*—See Hunter's Works, by Palmer, p. 288. After speaking of "metals perhaps not having the power of irritation beyond the adhesive," Mr. Hunter observes:—"This appears also to be the case with the introduction of glass, even in superficial parts: a piece of glass shall enter the skin just deep enough to bury itself; inflammation shall come on; the wound in the skin if brought together shall heal by the first intention; and the inflammation shall not exceed the adhesive, but rather degenerate into the disposition for forming a sac, by which means a sac is formed round the glass, and no disturbance is given to the irritability of the parts. This was the case with Mr. Knight, apothecary, who had a piece of glass three-fourths of an inch long run into the palm of his hand, and remained there for ten weeks, without any further inconvenience than retarding the motion of the hand, and sometimes giving a pricking pain when the sac was made to press upon the points of glass; this insensibility, however, arises from a sac being formed with such properties, but it cannot be assigned as a cause in the case of bodies moving, as pins."

There is one organ of the human body in which stony and metallic materials have been sometimes *seen* lying with impunity, and subject to the inspection of the practitioner. I allude of course to the eye.

For instance, Mr. Solomon of Birmingham has recorded a case in which a piece of stone remained wedged between the cornea and iris, the latter being indented by it. A short attack of primary ophthalmia was the result of the accident, which the patient received while breaking rag-stones. After the traumatic inflammation subsided, the intruded piece of stone for some years caused apparently little or no inconvenience. It could be seen in the anterior chamber, adhering to the iris by opaque lymph, but not encysted.[2]

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[1] *Malcolm.—Op. cit.*, vol. i. p. 307.

[2] *Solomon.*—See the "Association Medical Journal" for Sept.

Dr. Jacob describes a case in the "Dublin Medical Press" for December 1846, in which a piece of sharp stone, the fourth of an inch long, and a sixth of an inch in diameter, remained loose in the anterior chamber for four years before much irritation was set up.

Dr. Jäger successfully removed a triangular piece of glass, measuring five lines in diameter, from the anterior chamber of the eye, where it had remained five or six years, causing from time to time considerable pain and irritation. The vision of the patient was scarcely impaired after its extraction.[1]

Mr. White Cooper and other ophthalmic writers have recorded analogous instances.[2]

Indeed there seems to be a law of tolerance more general than the passiveness of living tissues to the presence in them of metallic bodies, and which comprehends within it, as a minor principle or proposition, the law of tolerance of living structures for metallic materials. This higher and more comprehensive law apparently amounts to this fact, that living structures may endure with impunity the presence of inorganic foreign materials, provided, perhaps, they are incapable

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15, 1854, p. 844. Mr. Solomon gives in the same communication a case where a small piece of steel was impacted in the iris for sixteen years; and other cases.

[1] *Jäger.*—See Ammon's "Zeitschrift," vol. iii. p. 103.

[2] *White Cooper.*—"On Wounds and Injuries of the Eye," p. 53, *sqq.* He gives a figure of a mass of iron, weighing 12 grains, which he withdrew from the posterior part of the eyeball, where it had remained lodged for several weeks. See also Walton's "Treatise on the Surgical Diseases of the Eye," 2d edit., p. 89, *sqq.*

of absorbing and retaining within their substance the secretions which are thrown out around them, or of acting in any way chemically upon these secretions. In other words, this higher general principle in surgical pathology consists of THE LAW OF TOLERANCE OF THE LIVING TISSUES FOR IMPERVIOUS AND INERT SOLID FOREIGN BODIES.

Before closing these observations on the tolerance of living tissues for metallic and impenetrable bodies, let me add, that in this as in many other instances, when once a general principle is established, we often find that it will serve us as a clue to the explanation of facts of an equivocal character already alleged, but which from their very strangeness, and previous inexplicability, were still regarded with doubt by some minds. For example, all surgeons know, that one old mode of attempting the radical cure of inguinal hernia was by the "golden stitch,"[1] or by encircling the neck of the hernial sac with a permanent gold wire; which wire was left embedded *in situ*, and the wound closed over it. The past history of surgery shows that this practice was followed, as far as the safety and life of the patient were concerned, with a degree of frequency and impunity which was startling, under our modern pathological ideas of the facility with which injuries and lesions of the peritoneum run on to dangerous degrees of inflammation and death. In the same way these ideas have again been upset in modern days, by the new modes of radical cure for inguinal hernia introduced by Wützer, Rothmund, Sigmund, Spencer Wells, and other surgeons, and which essentially consist in infibulating the hernial sac, and placing and keeping for several continuous days a stitch through this inverted portion of the peritoneal sac, in order that thus adhesive inflammation may be set up and the canal obliterated. We have proof of the innocuousness of this method of operating in the fact, that Rothmund has, it appears, practised the operation upwards of one thousand times without losing a patient, or seeing one case of fatal peritonitis excited by this prolonged puncture and transfixion of the peritoneum.

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[1] *Golden stitch, and old operation for the radical cure of hernia.*—In describing this old method for the radical cure of hernia, Purmann, for example, remarks, in reference to the frequency and comparative safety of the operation: "The famous and excellent operator at Leyden, Schmaltzius, was so expert at it, that you could scarce perceive how he performed it without a diligent circumspection; yea, I verily believe, he could have cut fifteen patients in an hours time, if he had had so many. When I was there he cut but six in an hour, all which succeeded; but then he took more time than ordinary."—("Chirurgia Curiosa," London, 1706, Book II. chap. 13, p. 161.) See subsequently, on this subject, Appendix No. II.

In all probability the explanation of the comparative safety of both the modes above alluded to, for the radical cure of hernia, is simply this:—the thread or needle used is *metallic*, and hence, in accordance with the general law which we have been considering, inflammation is usually excited by the metallic thread or metallic pin only up to the degree or stage of adhesion. If a *silken* thread is used for the purpose, then, as shown indeed by the result of various experiences upon the radical cure of inguinal hernia, the same operation is found liable to be attended by a higher and far more dangerous degree of inflammatory action.

Few surgeons have worked with more ability or more success at the radical cure of inguinal hernia, than Mr. Wood of King's College, London. In his earlier cases he passed organic threads through the peritoneum. But, he adds, "hearing much of the non-irritating properties of wire sutures, about that time reintroduced to public notice by Dr. Simpson of Edinburgh; and having had unfortunately a case which terminated fatally from pyæmia three weeks after the operation for the radical cure, the author was led to try ligatures made of metal. The *diminution* of the amount of suppuration which thereupon followed was *so marked*, that, with some modifications in the manipulation of the wire which were found necessary after a few trials, the plan now practised in most cases by the author was adopted with great advantage and success."[1]

SECTION II.—*Law of Non-tolerance of Living Tissues for the presence of Dead Foreign Organic Bodies.*

When foreign dead[2] organic bodies belonging either to the animal or vegetable kingdom, are lodged or embedded in the living tissues, they, as a general result, speedily produce morbid irritation and excitement, and a degree of inflammation which soon terminates in suppuration and ulceration.

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[1] *Wood.*—"On Rupture: Inguinal, Crural, and Umbilical," 1863, p. 92.

[2] *Tolerance of the tissues for living organic bodies.*—It would be quite out of place here to discuss the important pathological laws regarding the tolerance and non-tolerance of the tissues for living and dead entozoa, growths, tubercles, and other morbid deposits; or the marked tolerance of mucous surfaces for

In experiments upon the lower animals, I found pieces of lint, cloth, etc., lodged in the subcutaneous tissues, excite local suppurative inflammation, when portions of metal of equal size, lodged, in their neighbourhood, and at the same depth, excited only adhesive inflammation. See the experiments alluded to described at p. 458.

Foreign or dead organic substances are sometimes found lodging in and complicating wounds in the human subject, particularly gunshot wounds.

The walls of a gunshot wound, along its track through the soft tissues of the body, are often to a greater or less extent killed by the force and blow of the ball, and consequently slough. Whenever a portion of soft tissue is in this way deprived of vitality, and becomes a dead organic substance, it excites in the contiguous living structures suppurative and ulcerative inflammation, to such a degree as is necessary for the disjunction and elimination of the dead organic tissue.

When any portion of soft structure dies or sphacelates from any other cause, mechanical or morbid, it gives rise in the same way, for its removal and elimination, to suppurative and ulcerative inflammation in the contiguous living structures.

The same law holds true in regard to a piece of dead

metallic and impervious bodies, as seen in the wearing of false teeth, of pessaries, etc.

or necrosed bone. Suppurative and ulcerative action is set up in the living tissues around it. When a piece or splinter of bone is struck completely off by a gunshot wound, the lodgment of this separated fragment of bone prevents—sometimes for a very long period—the wound from closing, and keeps up constant morbid irritation and suppuration by its presence. The suppurative and acrid discharges produced in many gunshot wounds by the presence of portions of dead and carious bone, are often erroneously mistaken for the effects of the irritation of metallic bullets or foreign bodies that may happen to be lodged at the same time in the wound.

Pieces of cloth are occasionally buried in the structures of the human body by gunshot wounds, the ball carrying before it and with it portions of dress, etc. The law of the non-tolerance of living tissues for the presence of foreign organic bodies, is strongly illustrated by the irritation and suppuration to which such embedded portions of cloth give rise. The fact is one well known in military surgery, and is alluded to by various authors. Thus, for example, Mr. John Bell, in his "Discourses upon Wounds," when treating of the circumstances which may impede the healing of a gunshot wound, specially points out, that, as a cause of its slow cure and of its continuous irritation and suppuration, "there may remain some foreign body within the wound; now," he continues, "a ball *never* produces these symptoms; a broken and corrupted bone would presently be known by the black colour and fetid smell of the discharge; and if the slow healing of the wound is known to proceed from neither of these causes, then most likely it arises from some piece of *cloth* which has passed in along with the ball."[1]

In the practice of his profession, the surgeon often takes advantage of the same law; for when he wishes the sides of any artificial wound or opening which he has made *not* to adhere, he knows he can effect this purpose by lodging between the walls of the wound a piece of charpie or other foreign organic body; and he is further certain, by maintaining the foreign body in this position for a few days, that suppuration in the walls of the wound will be excited by its presence.

An extremely small and minute fragment of dead animal or vegetable substance is sufficient, in accordance with this law, to excite suppuration in the living tissues among which it is lodged. Several years ago, various eminent surgeons tried for a time the practice of cutting off both the ends of the ligatures with which they had tied vessels in amputations and other operations. The quantity of organic ligature required to be thus left buried in the closed wound around each deligated vessel was almost infinitesimally small. Mr. Lawrence calculated that the loop of silk thus left around each artery was, perhaps, not heavier than one-fiftieth of a grain; and the weight of flax or hemp thread required was not much more.[2] But though this vestige of foreign organic matter is not generally sufficient to prevent the union of the wound by the first intention, yet the practice has latterly been almost entirely given up by surgeons because they found that, as a general consequence, this minute fragment of organic ligature thus left embedded in the wound became inclosed in a small abscess, and by its presence gave rise to a slow process of suppuration and ulceration, by which the ligature was ultimately eliminated, and discharged from the surface of the body. "By some, both ends" of the ligature, says Professor Miller, "are cut away; in the belief that adhesion is thus favoured throughout the line of wound—as doubtless it is; and in the hope that the noose will become encysted, and give no further annoyance—as certainly will not happen. Adhesion under such circumstances is somewhat of a misfortune. For the noose and its contained slough are to all intents and purposes foreign matter; as such their presence will be resented by the surrounding living textures; and as such they will be extruded by suppuration. Sooner or later—often after cure has apparently been completed—deep abscess forms; painfully and slowly having approached the surface, pus is discharged—and with it, its cause, the noose. Not until this latter has been put forth will the pain and discharge cease."[1]

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[1] *John Bell.*—"Discourses on the Nature and Cure of Wounds," 3d edit., p. 203.

[2] *Lawrence.*—"A portion," says Mr. Lawrence, "sufficient to tie a large artery, when the ends are thus cut off, weighs between 1-50th and 1-60th of a grain; a similar portion of the thickest kind I have tried weighs 1-20th of a grain, and of the

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slenderest 1-100th. These ligatures do not interfere with the process of adhesion."—("Medico-Chirurgical Transactions," vol. vi. p. 163.)

[1] *Miller.*—"System of Surgery," p. 224.—See the similar opinion and statements of Liston and Chelius already quoted at p. 31. Professor Porta still deems the absorption of short silk, and still more of short catgut ligatures, as possible, and not unfrequent.—(See the "British and Foreign Medical Review," vol. xxii. p. 92.)

Long organic arterial ligatures, thrown around bleeding vessels, and left hanging out of surgical wounds, keep up in the same manner by their presence and contact a continuous process of suppuration along their track, as we have repeatedly pointed out in the course of the present work (see the opinions of Hunter, Cooper, Lawrence, etc., pp. 24 and 267, *ante*).

Organic sutures — formed as suture-threads have hitherto been of silk, flax, or hemp—act in accordance with the same general law of the non-tolerance of living tissue for foreign organic substances, and when left above a short time, always at last excite suppuration and ulceration by their presence.

Indeed the common organic sutures hitherto used by surgeons, do thus so often prove noxious centres and sources of irritation in the lips of wounds as to have caused, repeatedly, in the past history of surgery, their more or less partial or complete rejection from practice. Above a century ago, the published observations of Pibrac and Louis led, for a time, to the almost total discontinuance of sutures in closing and keeping in apposition the lips of wounds, whilst the same object was attempted to be obtained principally or entirely by the aid of position, plasters, and bandages. The best surgeons of modern times, while almost all returning again to the use of sutures, have very generally acknowledged the irritating and unhappy effects occasionally produced by them, particularly when they were of an organic nature, and detained above two or three days.[1]

[1] *Irritating effects of organic sutures.*—See on this subject the observations of Samuel Cooper (" Surgical Dictionary," 7th edit.,

In modern surgery, the substitution of suture-threads of metal for organic suture-threads of silk, hemp, etc., enables the surgeon to close his wounds perfectly and accurately with a material for the presence of which there is a tolerance—instead of a non-tolerance—in the living tissues of the body.

SECTION III.—*Exceptions to the Preceding Laws in Surgical Pathology.*

In pathology there are many general, but few or no universal laws. The two or three preceding general laws, like all other general laws in medicine, are liable to more or fewer exceptions, apparent or real. To understand the full practical value of these two laws or principles, let me here state one or two of the more important exceptions to them.

1. The presence of metallic bodies or threads is liable—like the presence of organic bodies or threads—to produce in living tissues absorption, with the formation of pus—or, in other words, suppuration and ulceration—provided it is combined with strong constriction of, or a morbid amount of pressure upon, these tissues. In fact, surgeons have used, as we shall see in Appendix No. III., metallic threads in this way, to produce, by firm, forced, and repeated constriction, rapid ulcerative absorption, in dividing the necks of polypi, or the solid walls of a fistula *in ano*. Here it might seem as if the metallic material excited by its presence, not adhesive,

p. 1211); Professor Pirrie ("Principles and Practice of Surgery," 2d edit., p. 124); etc. etc.

but suppurative and ulcerative inflammation. But this exception to the general law of the tolerance of living tissues for metallic bodies is more apparent than real. For the truth is that the resulting rapid ulceration and absorption in these instances are the effect of the mere strong mechanical constriction and pressure of the living tissues, and quite independent of the agent or material by which that constriction and pressure are produced. (See on this subject our remarks at p. 103.) The effect would equally follow, whether the ligatures were organic or inorganic, provided only the physical amount of constriction and pressure made by them upon the involved living tissues were sufficient in degree. But the observation becomes important in another point of view. For it shows us that we must not expect metallic, any more than organic suture-threads, to remain quite free from any chances of suppuration and ulceration in their courses or tracks, provided they are so placed in a wound as to drag and press greatly upon the included tissues. The living tissues will only in general tolerate, without suppuration or ulceration, metallic threads, on the condition that they are so placed and so adjusted as not to produce unnecessarily strong pressure or traction at any point or points upon the structures through which they pass. In accordance with these observations, we find that when once a point strictured or compressed by a metallic thread is relieved by partial ulceration from its simple morbid excess of constriction or pressure, the metallic thread will cease to divide it further, and will on the contrary remain quiescent. Hence it is that others have found, as I have done, that it is difficult or almost impossible to remove a large internal hæmorrhoid by one application of a metallic thread, as can be easily done by one application of an organic thread. A metallic thread cuts or ulcerates through the constricted hæmorrhoid till all over-tension and over-pressure are removed, and then remains quiescent around the remaining portion—in accordance with the law of the tolerance of the living tissues for metallic foreign bodies.

2. Though in surgery, organic threads and ligatures, as a general consequence, speedily produce, by their presence, suppuration and ulceration in tissues in contact with them; yet there occasionally occur in practice exceptions, real or apparent, to this common principle in surgical pathology. Sometimes—though very rarely—an effusion of coagulable lymph only, and not of pus, is thrown out around organic threads; or, in other words, their presence for five or six days, or longer, excites only adhesive, and not as usual, suppurative and ulcerative inflammation. Again, sometimes another result is seen, viz., that when silk or flax threads and ligatures are left in the living structures for weeks or months, they in the first instance excite, as usual, more or less suppuration and ulceration in the tissues immediately in contact with them; but after a time the secretion of pus ceases; then its absorption occurs; the included portion of thread becomes dried and rigid, like a non-porous, impervious, inorganic material; and subsequently it is fixed and encysted in its site by effused coagulable lymph. I have

repeatedly seen this series of changes in watching the effects of sutures in the lower animals;[1] sometimes one loop of suture-thread remaining moist and the centre of a purulent collection, while a contiguous thread was dried, stiffened, and fixed *in situ* by coagulable lymph and granulations. Similar examples occasionally occur in the human subject, as in those instances in which small ligatures are left, cut off short, upon the vessels of the omentum, and of torn false membranes, in cases of hernia and ovariotomy. Some years ago, in a case of complete and extensive laceration of the perineum, I brought the edges of the rent together an hour or two after delivery, by the usual deep quilled suture, and by some superficial stitches in the skin of the perineum, and the mucous surface of the vagina. Three days afterwards, the patient's medical attendant removed the quilled sutures, and the superficial cutaneous stitches; and the reunion of the parts was found complete. I did not see the patient from the day of operating till three months afterwards, when I was asked to ascertain if there was anything wrong in the vagina. In the posterior wall of the vaginal canal, in the site of the previous laceration, I found, still *in situ*, the two silk stitches, that had been used to bring the mucous walls of the rent into apposition, but which had escaped notice when the other threads were withdrawn. The embedded loops were dry and arid, and their sites marked by an accumulation of granulations.

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[1] *Tolerance in the lower animals.*—The elaborate experiments of Professor Porta of Pavia tend to show that the tolerance for organic threads is greater in the lower animals than in man.—(See the "British and Foreign Medical Review" for October 1846, pp. 89, *sqq.*)

Such exceptions, however, by their rarity only prove the extent and importance of the very law of which they thus form occasional variations. But perhaps they also suggest another consideration—namely, whether by any means we could render our silk or hempen surgical threads as impervious, and hence as unirritating, as threads of metal. Could this be effected by making them water-proof or liquid-proof, with a coating of caoutchouc, or with a solution of acetate of alum, or by any other means mechanical or chemical? Is hence catgut really so very superior to silk as Porta's experiments seem to show? Was it from superior impenetrable qualities of this kind that Fallopius recommended for suture-threads the "*linum Brixiense*," as never putrefying (*nunquam marcescit*);[1] and Read bepraised Flemish hemp?—"The Low-countrey white threed, made," says he, "of the best hemp, hath no fellow."[2]

[1] *Fallopius.*—See his "Opera Omnia," 1606, tom. ii. p. 177.

[2] *Read.*—See his "Treatise of Wounds," p. 52.

No. II.

See Page 89.

METALLIC SUTURE-THREADS—THEIR HISTORY AND ADVANTAGES.

IT is in accordance with the first general pathological law discussed in Appendix No. I., of the tolerance of the living tissues for metallic bodies, that latterly the use of metallic threads of capillary wires has come into practice as suture-threads for wounds. In consonance with the other pathological law, which we have tried to enunciate in the same Appendix, of the non-tolerance of the living tissues for the presence and contact of organic bodies, the employment of organic threads has come to be looked upon with doubt and suspicion by many leading surgeons.

Before tracing the introduction and history of various metallic suture-threads into surgery, let us first glance for a moment at the history of organic suture-threads, or rather at the history of the materials of which they are composed.

SECTION I.—*Organic Suture-Threads—their Materials.*

In modern surgery, silk has long formed the material most generally employed for the threads which surgeons used, both to stitch together the lips of wounds, and as ligatures for the deligation of the mouths of the blood-vessels cut across by the course of the knife. Various other materials from the animal and vegetable kingdoms have been at various times suggested and tried by different operators, as surgical threads and ligatures, such as silk-worm-gut; catgut; wool; inkle; hairs; strips of leather, of parchment, of cow-hide, and of buckskin; strings formed of tendon and of nerves; lines of isinglass; filaments of caoutchouc; threads of flax, hemp, cotton, etc.

In olden surgery threads of flax, hemp, and latterly of silk, seem to have been most commonly employed for sutures.[1] Some forms, however, of surgical threads that are supposed to have been first proposed in modern times were not unknown in ancient times. For instance, there has been considerable discussion as to who first proposed surgical threads made of animal materials. Catgut was suggested as a proper substance for sutures and ligatures, in 1813, by the learned Dr. Thomas Young[1]—he and others having fallen into the physiological error of thinking that animal suture and ligature threads might be readily removed by the act of absorption in the living body; and it has been doubted and questioned whether the proposal to use animal ligatures was or was not made earlier in America by Dr. Physick of Philadelphia.[2] But in all probability catgut, the form

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[1] *Materials of ancient surgical threads.*—Few or none of the ancient medical authors speak explicitly as to the materials of which their surgical threads were composed. In one passage Galen incidentally alludes to suture-threads being made of lint or wool.—(Kühn's Galen, vol. xviii. B. p. 752; or Comment. in Hipp. de Med. Off. II. 10.) Paulus Ægineta mentions threads of wool for stitching wounds left by the removal of a portion of skin from the upper eyelid for the cure of trichiasis.—(Dr. Adams' Translation, vol. ii. p. 260.) Fabricius Hildanus recommends the vessels in amputation to be tied, when deligation is used, with a hempen thread, "filo cannabino;" and he further speaks of sewing the edges of the wound together with silk, "filo æquali ac levi quale est sericum."—("Opera," Frankfort-on-the-Maine, 1646, pp. 814, 815. Severinus advises his followers to use for wounds a slender suture-thread of cleaned cotton, "funiculum tenuem è gossypio mundo."—(Chirurgiæ Efficacis, cap. cxxii.) Fallopius, in his treatise on wounds, makes the following observations on the best threads for suture:—"Filum autem sit robustum, sed non nimis crassum nec durum. Tertio sit æquale, ita

ut præter æqualitatem non habeat nodos interpositos, nec sit putrescibile, quare fila ex gossypio vel lana non sunt opportuna. Galenus autem lib. 3, meth. cap. ult. affectabat filum molle ac satis durum, unde dicebat ipse filum Caietanum optimum esse; vel loco ejus utebatur sericino; quare filum lineum sit vel sericinum. Linum autem Brixiense optimum est, et nunquam marcescit, ipso ergo utendum est vel sericina materia, quæ itidem optima est. Filum præterea sit album, vel cremesinum tantum; nigrum enim vel alio colore infectum malum est."—("Opera Omnia," tom. ii. p. 177.)

[1] *Suggestion of catgut ligatures by Dr. Young.*—See his "Introduction to Medical Literature," 1813. "I have often," says Dr. Young, "wished to try ligatures of catgut which might be absorbed" (p. 424). In the "Edinburgh Medical and Surgical Journal" for January 1819, vol. xv. p. 155, Dr. Young states that he proposed catgut ligatures to several surgical friends ten years before, or in 1809.

Introduction of animal ligatures by Dr. Physick.—See Reese and Jamieson's American edition of Cooper's "Surgical Dictionary," article "Ligature." They observe: "To our distinguished countryman, Professor Physick, of the University of Pennsylof animal thread or ligature that has been most frequently tried in modern practice, was employed in surgical sutures eight or nine hundred years ago. The celebrated Arabic writer Rhazes, who practised at Bagdad about A.D. 900, speaks[1] of stitching up wounds of the abdomen with a thread made of the string of the lute or harp ("*corda liutti vel cithare*").[2] And another Arabian author, Albucasis, who lived a century or two later, alludes in the same class of wounds to stitching a wounded bowel with a fine thread made of the twisted intestine of an animal, "*filo subtili, quod abstersum est ex intestino animalis annexo.*"

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vania, is undoubtedly due the honour of having first introduced, in 1814, what is known as the animal ligature into surgical practice. His ligatures are made of chamois leather."

[1] *Rhazes.*—See his "Continens," lib. xxviii.; p. 344 of Venice edition of 1509.

[2] *Harp-strings formed of catgut.*—At least the strings of the ancient Egyptian, and hence probably of the Arabic harp, were made of catgut. "The strings of Egyptian harps were," says Sir J. Gardner Wilkinson, "of catgut, as of the lyres still used in Nubia."—(Popular Account of the Ancient Egyptians, vol. i. pp. 111 and 118, etc.) "Wire strings," he elsewhere observes, "were not used by the Egyptians in any of their [musical] instruments, catgut being alone employed."—*Ib.* p. 125. The strings or cords of the old Greek harp were, in the time of Homer, formed, as we learn from one of his similes in the Odyssey, of the twisted intestine of the sheep, ἐϋστρεφὲς ἔντερον οἰός (Book xxi. l. 408). The word "cord," as applied to the strings of the harp, etc., is itself, in fact, sufficiently indicative of the material of the strings, as originally the term χορδὴ simply signifies intestine.

[3] *Albucasis.*—"Methodus Medendi," lib. ii. c. 85.

SECTION II.—*Uses of Metallic Threads in Olden Surgery, for other Purposes than for Sutures.*

Metallic threads have been used for various purposes in surgery from the earliest historical periods;[1] though, let us first observe, not as sutures for wounds, or ligatures for vessels. They have been employed, for example, in surgical practice, for the following objects:—

1. In adjusting fractures of the lower jaw, Hippocrates, among other more important directions, advises that, after the broken ends of the bone are placed in apposition, the teeth on either side of the wound should, if they be disturbed and loosened, be tied together, two or more of them, with a gold thread.[2] Paulus Ægineta,[3] and after him various Arabic authors, recommend a thread of gold to be applied in the same manner for the

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[1] *Antiquity of metallic threads.*—It is perhaps not undeserving of remark, that gold and silver seem to have been drawn into wires, and in this form used for embroidery, etc., from a very early era. Gold wires and their mode of manufacture, are referred to in Exodus (chap. xxxix. 3). "Silver wire was," according to Sir J. Gardner Wilkinson, "known in Egypt about 3300 years ago, being found at Thebes of the third Thothmes . . and it was probably known and used nearly as soon as gold wire, which we find attached to rings bearing the name of Osirtasen the First, who lived more than 600 years earlier."—(Wilkinson's Ancient Egyptians, vol. ii. p. 82.)

[2] *Hippocrates.*—Adams' edition of his Works, vol. ii. p. 594. On the use of metallic sutures in compound fractures of limbs, see Icarte in the "Journal de Médecine," 1775, p. 164.

[3] *Paulus Ægineta.*—Adams' edition of his works, vol. ii. p. 445.

same injury; and Wallner[1] has in modern times, for the same purpose, bound a silver thread around the front teeth in central fractures of the lower maxilla.

2. In attempting the radical cure of inguinal hernia, some surgeons of the middle ages, as Berand Metis,[2] Franco, Fallopius,[4] Ambrose Paré,[5] etc., applied what they termed the "golden stitch," the "golden tie," (or "*punctum aureum*"), to the neck of the hernial sac, surrounding and constricting it, with or without the exclusion of the spermatic vessels and cord, by a golden thread, after it was cut down upon. The golden thread was left permanently *in situ* around the neck of the sac; sometimes with, as described by Fallopius, a slim defensive gold ring or crescent around the cord (*circulum seu semicirculum ex auro non valde crassum*); and the cutaneous textures healed over all. Besides applying a permanent gold thread or wire for the cure of hernia,

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[1] *Wallner.*—See South's edition of Chelius' "System of Surgery," vol. i. p. 529.

[2] *Berand Metis.*—See Guy de Chauliac's "Chirurgia," tr. vi., doct. 2, cap. 7; or edit. of Leyden, 1572, p. 417.

[3] *Franco.*—"Traité des Hernies; de toutes leurs especes, etc.," Lyons, 1561, pp. 59, 60.

[4] *Fallopius.*—"Opera Omnia," tom. ii. p. 313.

[5] *Ambrose Paré.*—English edition of his "Workes," p. 309. Paré's account is accompanied with sketches of three instruments required for performing the "punctum aureum." He figures—1. A crooked needle, like a modern aneurism-needle, with "the golden wyre put through the eye" of it; 2. Mullets or pincers to remove the superfluous ends of the wire; and 3. Mullets or pincers to twist the ends of the wire together. These instruments very precisely resemble some of those proposed to be used in applying metallic sutures in modern times.

Paré speaks of occasionally using, for the same purpose, a temporary wire or thread of lead.

3. One mode of treatment long pursued in the management of fistula in ano consisted in passing a flaxen thread or ligature along the track of the fistula and bowel, and gradually cutting through the intervening tissues, by the constriction and pressure of the ligature. This operation is described at length in one of the essays usually included among the Hippocratic writings.[1] Foubert, a French practitioner of the last century, substituted a metallic or leaden thread for the flax thread formerly employed in this operation.[2] The practice of dividing the structures placed between the bowel and the tract of the fistula with a ligature of lead was, with various modifications, subsequently adopted by Bosquet, Desault, Sabatier, and other continental surgeons.

4. From an early period in surgery polypi have been removed by cords or ligatures applied and tightened around their pedicles.[3] In the sixteenth century, Ga-

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[1] *Hippocratic writings.*—Adams' edition of Hippocrates' works, vol. ii. p. 817.

[2] *Foubert.*—See Leblanc's " Précis d'Opérations," vol. i. p. 97.

[3] *Polypi removed by ligatures in ancient surgery.*—Some ancient authors recommend, in the removal of polypi and other parts, that the ligature should be pulled alternately at either extremity, or employed with a sawing motion, like that used in working the écraseur of M. Chassaignac. Rhazes indeed advises the ligature thrown around the base of the polypus to have knots placed upon it at short distances, that the surgeon may thus work it with a greater sawing power.—(Divisio morborum, cap. xlii. p.f. 62.) Other Arabian authors, as Albucasis and Avicenna, describe the same operation of sawing through the stalks of polypi with knotted threads. Mesue recommends for the pur-

briel Fallopius recommended a thread or wire of brass, steel, or iron, like that used in harpsichords (*filum æneum vel chalybeum satis crassum, vel ferreum, ex quo arpicorda constituuntur*), introduced through a silver canula, as the best ligature for the purpose of strangling the base of nasal polypi;[1] and a century ago Levret[2] called the attention of the profession to the advantages of removing uterine and other polypi by the constriction of a silver wire, introduced through a double silver canula. Both of these forms of metallic ligature have been adopted by various followers.

SECTION III.—*Use of Metallic Pins for Sutures.*

In the preceding instances the metallic wires or threads were not used as suture-threads, to unite the edges and walls of wounds in the soft parts. And when first metals were used for this last purpose, they were employed in the form of fixed bodies, and not as flexible threads. For when Galen, Celsus, Oribasius, and other

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pose a ligature made of several horse-hairs tied together with knots.—(Adams' Paulus Ægineta, vol. ii. p. 291.) In the thirteenth century, the Italian surgeon Bruno, the reputed friend of Petrarch, orders these sawing knots to be placed upon the ligatures at about the distance of a finger breadth from each other; and whenever the root of a nasal polypus is very deep, he recommends the extremities of the knotted ligature to be pulled alternately till the polypus is detached.—("Chirurgia Magna et Parva," lib. ii. c. 12.)

[1] *Fallopius.*—"Opera Omnia," tom. ii. p. 298, where a figure of the canula and loop of thread is given.

[2] *Levret.*—"Sur la Cure Radicale de Plusieurs Polypes," 3d edit., p. 482.

ancient surgeons kept the lips of some of their wounds united for the requisite time by the metallic pins of their fibulæ or clasps,[1] and when, in later times, the metallic needle of steel, bronze, silver, or gold, was left in for a few days for the same purpose, in the well-known form of the twisted suture in harelip, etc., the material of the suture was so far essentially metallic.

In the seventeenth century Fabricius ab Aquapendente invented—as a modification of the fibula—a metallic suture which was intermediate between the pin and the thread. He passed through the lips of the wound long needles of iron or brass previously made flexible and soft over burning coals—except at their sharpened point. Then, after they were thus passed, he fixed them, by reversing or turning back both extremities, and allowed them to remain till the wound was agglutinated. Besides, Fabricius seems to have entertained very correct views of the advantages of metal, as compared with thread, in the stitching of wounds, and to have forestalled most of the modern pathological views upon the subject.[1]

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[1] *Surgical Fibulæ.*—On the fibula of Celsus see the long dissertation of Rhodius, "De Acia dissertatio ad Cornelii Celsi mentem," etc.; Fabricius ab Aquapendente's "Opera Chirurgica," Leyden edit., 1723, pp. 155 and 670, etc. etc. I have repeatedly seen Mr. Edwards bring together the lips of recent wounds by transfixing them with the *aciæ* of those so-called "safety-pins," made in the shape of an arc and bow, that are now much used in fixing dresses, and which, though a modern English patent, are essentially and entirely a repetition of the most common form of the old Roman fibula. On the use of fibulæ by Galen, in wounds intended to be united by primary union, see a preceding page (p. 134).

Section IV.—*Use of Metallic Threads for Sutures.*

The idea itself of employing metallic threads for surgical sutures is not entirely modern, however much the practice may be deemed so. For without dwelling on their employment in ancient mythical surgery,[1] let me remark, that in his learned dissertation on the

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[1] *Fabricius ab Aquapendente.*—" Si licet aliquando paradoxum vobis afferre, dixero potiùs, meam fibulam potiorem esse ; propter rationes ex comparatione desumptas à juvantibus et nocentibus, si quidem fibula Fallopii, ex filo facta, mordet ubique carnem ; quia filum asperum est, et inæquale, cum sit tortum, acus verò lævigata est et perpolita. Rursus, filum mordendo labia vulneris transversè ea perrodit, quod experientia passim patefacit, et confirmat ; at acus flexibilis, cum rotunda sit, et lævigata, nihil istiusmodi facit ; exemplo sint annuli aurei, aut ferrei, qui auribus perforatis, diutissimè gestantur, utcunque penduli sint. Rursus, si filum valentius stringatur, interdum rumpitur, quod non patitur acus mollis, ferrea, aut ænea. Amplius, filum est materia, qua facilè tenditur, et laxatur ; ferrum verò flexibile neutiquam laxatur. Insuper, laxitas ex filo dupliciter succedit, tum ex laxa fili natura, tum ex corrosis labiis ; unde etsi à filo labia vulneris ad mutuum contactum adducuntur, non tamen adducta conservantur ; quia propter fili naturam, dupliciter laxantem disjunguntur, et hiant ; sed neutram laxitatem ex acu flexibili, rotunda, et perpolita exspectare opportet. Ultimò, filum non difficulter putrescit à sanie, et ichoribus ; at acus ferrea, aut ænea, innocuus est ab hujusmodi labe. Quod si tandem addatis, æs et ferrum habere vim refrigerandi, et adstringendi, vulneris glutinationi consentaneum erit ; et hoc est argumentum veritatem paradoxi omnino comprobans et confirmans."—(See his " Opera Chirurgica," Leyden, 1723 fol. 671.

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[1] *Ancient mythical surgery.*—There is, for example, an old mythic story of gold thread being used in Ireland many long centuries ago as a suture-thread in a wound, though rather on the principle of beauty and conformity than on the principle of the tolerance of the living tissues for metals. Among the many ancient legendary heroes of Ireland, Conchobar, or Conor MacNessa, king of Ulster, holds a prominent place. In the late Professor Eugene O'Curry's rich and learned "Lectures on the Manuscript Materials of Ancient Irish History," is given the translation from the Book of Leinster of one account of Conchobar's death, written or copied about the twelfth century Conchobar is struck down with a sling stone. "Its two-thirds entered his head." "In the meantime his physician was brought to Conchobar, namely Fingen. He it was that could know by the fume that arose from a house the number that was ill in the house, and every disease that prevailed in the house. 'Good, said Fingen; 'if the stone be taken out of thy head, thou shalt be dead at once; if it is not taken out of it, however, I would cure thee, but it would be a blemish upon thee.' 'The blemish,' said the Ultonians, 'is better for us than his death.' His head was then healed, and it was stitched with *thread of gold*, because the colour of Conchobar's hair was the same as the colour of the gold" (p. 640). It is further alleged, that the date of this golden stitching was upwards of 1800 years ago (see pp. 277, 642, etc.); and that Conchobar lived on for seven years after it, or to the day of Christ's crucifixion (p. 642). There are far older feats still in Irish mythical surgery; as, for example (pp. 246-250), the preparation by the army surgeons of medicated baths for the wounded, and the supply of a wonderful silver arm by the Irish Esculapius, Diancecht, and Creidné, the great worker in metals, to the king of the Tuatha-De-Dananns, Nuada, whose upper extremity was hewn off by a blow of the sword of the Firbolg warrior Sreng, at the first battle of Moytura. Some Irish annals place this battle far enough back, viz., to a date earlier

"Acia" or Fibula of Celsus, John Rhodius alludes to many different forms of thread, as the *filum* "*lineum, laneum, sericum, xylinum, aureum, argenteum, ferreum, plumbeum.*" After speaking of the employment of gold and iron threads in the industrial arts, he alludes to the question of these two metallic threads being capable of use in surgical sutures; and evidently without ever having tried them, he condemns them as unfit for such a purpose. "*Alterutrum certè subtile admodum continendis vulnerum oris sine evidenti doloris molestia vix conferre potuit.*"[1]

During the last century, however, metallic sutures appear to have been used, in some isolated examples, by one or two surgeons. Thus, Purmann, "Chief Chirurgeon of the City of Breslaw, in Germany," as he is styled on the title-page of the English edition of his "Chirurgia Curiosa," used, with alleged great advantage, metallic sutures in wounds of the tongue. The metallic sutures which he employed consisted of what has been specially recommended in modern times—viz., silver threads or silver wire.[2] Needles of gold and silver were long preferred by most surgeons in applying the twisted suture

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than the reputed era of the siege of Troy.—(See Dr. O'Donovan's "Annals of the Kingdom of Ireland by the Four Masters," vol. i. p. 17; and O'Flaherty's "Ogygia," vol. ii. p. 18.)

[1] *Rhodius.*—See "De Acia dissertatio," etc., Copenhagen edition of 1672, pp. 192 and 194.

[2] *Purmann.*—See his "Surgery," Part I. chap. 6; referred to by Heister in his "System of Surgery," London edition of 1768, p. 92. "Purmann affirms," observes Heister, "that he made use of *silver* threads in sutures upon this part of the tongue to great advantage."

for the cure of harelip. In his "Elements of Surgery," published in 1746, Mr. Mihles speaks of employing silver and gold threads in the operation for harelip instead of pins, and figures a needle fitted to draw these metallic threads through the sides of the cleft lip. This is the first representation that I know of, of a needle intended to pass capillary wires in surgery. It seems split at its blunt extremity to receive the thread.[1]

In times nearer our own, the celebrated French military surgeon, Baron Percy, seems to have held most correct views of the relative advantages of metallic over organic suture-threads, and particularly recommended them in the operation for harelip. His metallic threads were made of lead, or of a fine wire of gold or platinum covered with lead.[2]

During the current century the first surgeon who appears to have used metallic threads much in practice, was the late Professor Dieffenbach of Berlin. In a paper on Staphyloraphy published in 1826, he has detailed several instances of that operation, in which he used leaden thread to unite—and keep united—the sides of the divided palate. He preferred for this purpose threads of lead to threads of silk, as he found the ends of the leaden thread could be made—by mere twisting of their elongated extremities—to bring into contact the raw sides of the wound more easily than could be effected by attempting to tie and knot the ends of silk threads, by introducing the fingers so deeply within the cavity of the mouth.[1] "The difficulty," says Professor Fergusson,[2] "of keeping the first noose steady has often been alluded to; the lead ligatures, by being twisted together, obviate this difficulty." The metallic suture in staphyloraphy has been alluded to by many later surgical writers—and modified by some—as, for example, by Mr. Liston in 1831,[1] Velpeau,[2] Pancoast,[3] etc.

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[1] *Mihles.*—"Elements of Surgery," p. 277; and Tab. I. Fig. *u*.

[2] *Percy.*—See Laurent's "Vie de Percy," p. 116; and Ollier's essay, "Des Sutures Métalliques," 1862, p. 9. Malgaigne, when speaking of suture-threads in general, observes :—"Il ne faut pas omettre que Percy avait voulu substituer le fil de plomb à *tous* les autres moyens."—(See his "Manuel de Médecine Opératoire," 6th edit., p. 55.)

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[1] *Dieffenbach on lead threads in staphyloraphy.*—In the "Lancet" for 1826, vol. xi. p. 405, in a detailed account of Professor Dieffenbach's operation for Staphyloraphy, it is stated that —"The principal difference in Dieffenbach's mode of procedure from those recommended by Graefe, Roux, Souchet, Jousselin, and Alcock, consists in the substitution of a finely-drawn *lead wire* for the ordinary ligatures. It is necessary that the lead should be as pure as possible; the wire needs only be a little larger than a stout pin; and if used when recently drawn it will be found just as yielding as a waxed thread. . . . The needles having been unscrewed or cut off, the extremities of the ligature are then twisted once or twice slightly round, and put on one side of the mouth until the other ligatures are introduced. It is then recommended to commence the closing of the edges of the velum, by twisting with a forceps the ends of the anterior ligature carefully around each other, until the edges of the wound are brought into contact. The twisted wires are to be cut off within about a quarter of an inch of the palate, and turned forward upon the roof of the mouth. The second ligature is to be managed in the same manner, and so the third, or as many as there may be. Should the inflammation be so violent as to cause great tumefaction of the parts, the ligatures may be untwisted to the necessary extent to relieve the tension, without altogether setting the edges free; and the wire may be again twisted tighter when the inflammation subsides. To remove these ligatures it is only necessary to cut the wire on either side above the twisted part, when the whole ligature may be easily brought away by a little lateral motion."

[2] *Fergusson.*—"Observations on Cleft Palate and on Staphyloraphy" in the Medico-Chirurgical Transactions, vol. xxviii. p. 295.

Metallic sutures have been adopted in other plastic operations besides that of staphyloraphy. In his "Practical Essays on Plastic Surgery," published in 1854, Mr. Spencer Wells observes: "The *lead* suture is sometimes useful in deep operations. A piece of soft lead wire is armed at both ends with a short needle. These are passed, by means of forceps or a needle-holder, from within outwards, and the needles removed. The ends of the lead wire are twisted together until the wound is brought into apposition. They are then cut off. This is the easiest suture to apply in cases of vesico-vaginal fistula when deep-seated."[4]

In the "Lancet" for November 29, 1834, there occurs a remarkable communication regarding metallic sutures, from the pen of Mr. Gosset, formerly surgeon to Newgate, London. Mr. Gosset first records his successful treatment of a case of old-standing vesico-vaginal fistula, where, after having pared off the callous edges, he united the revivified lips with three sutures made of "gilt-wire." He fixed the wires by twisting them. One suture was removed at the end of nine days, a second at the end of twelve, and the third was allowed to remain until three weeks had elapsed. The fistula was completely closed. But Mr. Gosset shows that he was perfectly aware of the advantages which metallic possess over organic threads in other surgical wounds, and states that the object of his communication is to introduce to the notice of the profession "gold wire or rather silver-gilt wire"—that is, silver wire coated over or gilded with gold—as a suture-thread. "The advantages," says he, "of the gilt-wire suture are these: It excites but little irritation, and does not appear to induce ulceration with the same rapidity as silk or any other material with which I am acquainted; indeed, it has scarcely any effect of the kind, except when the parts brought together are put much upon the stretch; you can, therefore, keep the edges of a wound in close contact for an indefinite length of time, by which the chance of union is greatly increased. I have used it now in very many operations, as after the extirpation of the breast, tumours of various kinds, and for bringing the lip together after the removal of a cancerous growth, in all of which cases it answered extremely well. In the larger operations above mentioned, I do not, however, particularly recommend it, as there is more difficulty in applying it than the common suture. It is in minute and delicate operations—such as harelip, staphyloraphia, and for the closure of fistulous openings, where success mainly depends upon a speedy union of the parts—that the advantages of the gilt-wire suture are most manifest."[1]

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[1] *Liston.*—"Elements of Surgery," part ii. p. 193:—"A ligature either of thread or of *pewter* wire can thus be conveyed at once; if the latter is employed, it is secured by twisting, and the ends cut off by pliers."

[2] *Velpeau.*—"Nouveaux Eléments de Médecine Opératoire," 1832, tom. ii. pp. 96, 97.

[3] *Pancoast.*—"Treatise on Operative Surgery," 1844, p. 261.

[4] *Wells.*—"Medical Times and Gazette" for July 29, 1854, p. 109.

The use of metallic threads has been applied by other European surgeons to the stitching of common surgical wounds. In the "British and Foreign Medical Review" for April 1846, p. 286, it is stated that platinum wire as a suture-thread has been "successfully employed at Guy's Hospital by Mr. Morgan." I have been informed by one of his pupils, that for a year or two, Mr. Morgan used platinum wire in almost every wound that he required to stitch. A colleague of Mr. Morgan's at Guy's Hospital—the late Mr. Bransby Cooper—in his "Lectures on Surgery," published in 1851, when speaking of the treatment of common surgical wounds by the interrupted suture, observes that this, "the interrupted suture, is the one most frequently employed by surgeons, and silk is the ligature generally used; but platinum wire is preferred by some surgeons. As, however, it is rarely necessary or right to have the sutures in the wound longer than forty-eight hours, I think," Mr. Cooper adds, "it signifies little whether platinum wire or silk be employed."[2] Again, Mr. Guthrie, when describing the treatment of wounds left by amputation, directs that "the common integuments of the stump should be drawn together in primary amputations by sutures formed of flexible leaden wires ; by threads of silk, if leaden wires be not attainable."[1]

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[1] *Gosset.*—See his paper on "Calculus of the Bladder—Incontinence of Urine—Vesico-Vaginal Fistula. Advantages of the Gilt-Wire Suture," in the "Lancet" for November 29, 1834, p. 345.

[2] *Bransby Cooper.*—"Lectures on the Principles and Practice of Surgery," p. 54.

But the subject of metallic ligatures has met with more attention in America than in Europe. In 1831, Dr. J. P. Mettauer of Virginia employed them with perfect success in operating in a very aggravated case of laceration of the perineum and rectum, produced, the year previously, by a tedious labour. The laceration extended as high as three inches upwards, along the anterior wall of the rectum. After sufficiently removing and denuding the hardened edges of the lacerated cleft, and the parts exterior to them, Dr. Mettauer stitched carefully together the abraded surfaces with ligatures of lead wire.[2] "As the ligatures were applied they were tightened, so as to bring the abraded surfaces in contact; and then their ends were twisted together, and cut off of convenient length. About twelve ligatures were required to close the breach. From time to time the ligatures were tightened by twisting them, and the vaginal margins of the laceration cauterized with nit. argent. to favour the formation of granulations, which it was judged would greatly strengthen the union in this part"

Guthrie.—See his Lectures on the more important points of Surgery, in the "Lancet" for June 12, 1852, p. 555 ; and his "Commentaries on the Surgery of the War in Portugal, etc." 5th edit., 1853, p. 72.

[2] *Mettauer.*—"A case of ununited Parturient Laceration of the Recto-Vaginal Septum, successfully treated with Metallic Ligatures. By John P. Mettauer, M. D., of Prince Edward county, Virginia;" in the "American Journal of the Medical Sciences" for 1833, vol. xiii. p. 113.

(p. 114). The leaden suture-threads were not removed till six weeks, "the parts having united perfectly." In concluding his account, Dr. Mettauer observes, "leaden ligatures were preferred in the management of the foregoing case, as experience had proven them, not only less irritating and liable to cut out when tightly drawn than any other material with which I am acquainted, but infinitely more convenient and effective in maintaining a uniform and perfect apposition by the ready facility of simply twisting them, and—a proof that the leaden ligature may act forcibly for a long time without cutting out—when they were removed in the present instance, it could not be perceived that any material encroachment had been made upon the margins of the cleft" (p. 115).

Fourteen years after recording his first case in the American Journal of Medical Sciences, Dr. Mettauer[1] reported six additional instances in which he had successfully operated for extensive lacerations of the perineum, using the leaden suture-thread, usually cutting it out, however, earlier than in his first case, or apparently from eight to twelve days after its insertion; and leaving the extremities of the wire longer than at first, in order that they might be more readily seized and tightened by an additional twist or two, if they offered to become loose during the first few days following the operation.

In the same year (1847) in which this second essay, on the cure of lacerated perineum with metallic sutures appeared, Dr. Mettauer published an account of some cases of vesico-vaginal fistula which he had treated on similar principles. In his first case, the opening in the back wall of the bladder was "fully the size of a Spanish milled dollar, and nearly circular." Its edges were denuded and brought together with eight leaden sutures; and after the extremities of these sutures were twisted and tightened, the opening was perfectly closed in every part of it, and the line of contact of the opposing surfaces measured two inches. On the third day the wires were tightened, and again on the seventh. On the thirteenth day the ligatures were removed, and perfect union was found to have taken place along the whole line of contact. The cure was complete, and the woman bore two children subsequently without any return of the accident. Dr. Mettauer operated in five other cases of vesico-vaginal fistula, but not always with the same success. In his second case, the fistulous opening was diminished, but not obliterated, after eight operations. In two of the six cases Dr. Mettauer employed thread-sutures, but he did not "find them to answer so well as the metallic." His results, however, on the whole, were so favourable as to induce him to conclude with the strong allegation: "I am decidedly of the opinion that *every* case of vesico-vaginal fistula can be cured, and my success justifies the statement."[1]

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[1] *Mettauer.*—"See the American Journal of the Medical Sciences" for April 1847, p. 314, *sqq.*

My friend Dr. Marion Sims, of Paris, and formerly of New York, published in 1852 an essay on "The

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[1] *Mettauer.*—"American Journal of the Medical Sciences" or July 1847, p. 117, *sqq*.

Treatment of Vesico-Vaginal Fistula," describing his mode of operating, and his specialities of management in this class of affections. In this essay Dr. Sims, among other suggestions, recommended the lips of the fistula, after they were refreshed by the surgeon's knife, to be held together by threads of silver wire used as a suture. At the anniversary meeting of the New York Academy of Medicine, for 1858, Dr. Sims read, and subsequently published, a discourse upon the use of "silver sutures,"[2] displaying, to adopt his own words, "all the ardour and enthusiasm of a devotee." In this discourse he proposes to extend—and relates, indeed, various cases, showing that he had in his own practice extended—the use of silver sutures from vesico-vaginal fistulæ to all the common wounds and operations of surgery. Speaking of silver wire as a suture, he remarks, "From the day its wonderful effects were witnessed in vesico-vaginal fistula in 1849, I have never used any other suture in any department of surgery" (p. 32); and "I declare it," he elsewhere observes, "as my honest and heartfelt conviction, that the use of silver as a suture is the great surgical achievement of the nineteenth century" (p. 8). Writing in 1858, he foretells that "the next eight years will not find an edu-

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[1] *Marion Sims.*—"American Journal of the Medical Sciences" for January 1852, p. 59; or Braithwaite's "Retrospect of Medicine" for 1852, vol. xxvi. p. 341; or Ranking's "Half-Yearly Abstract of the Medical Sciences" for 1852, vol. xv. p. 231.

[2] *Marion Sims.*—"Silver Sutures in Surgery: the Anniversary Discourse before the New York Academy of Medicine." By J. Marion Sims, M.D. New York, 1858.

cated physician anywhere who will dare to use silk sutures"(p. 45); and he states, with regard to the discovery of anæsthetics in surgery, that "in practical results of permanent benefit, it is absolutely contemptible when compared to those from the universal use of silver sutures." "My language is nowise extravagant; and I shall yet live to see the day when the whole profession of the civilized world will accord to this simple discovery the high position of being the most important contribution as yet made to the surgery of the present century" (p. 46).

The very earnest and unusual terms in which Dr. Sims thus describes the advantages of silver sutures, indicate at least a profound and intense conviction on his part of their great and unqualified superiority over sutures of silk and common thread.

SECTION V.—*Choice of Metals for Suture-Threads.*

In the preceding notices we have found different surgeons using threads of different metals for sutures: Mr. Morgan employing platinum; Dieffenbach, Wells, and Mettauer, using lead; Purmann, Mihles, and Marion Sims, recommending silver; and Gosset adopting silver wire coated with gold. The choice of the metal is perhaps a matter of no great importance, provided only it be not oxidizable when in contact with the tissue, and be sufficiently pliant and sufficiently strong.

In the "Medical Times" for June 19, 1858, I stated that I believed iron-wire or iron-thread to be the cheapest, strongest, and perhaps altogether the best metallic thread for surgical purposes (p. 626). In comparative experiments with other metallic threads on the lower animals, and in some observations on the human subject, I found it equally as unirritating and passive in wounds and living tissues as threads of gold, silver, platinum, palladium, lead, etc. For several years past, in vesico-vaginal fistula, and in all other operations, I have used iron threads, or iron capillary wires only.

To prevent iron threads from any mischances of oxidation during use, they may be coated with silver or gold; or still better, with tin or zinc, as in the so-called "galvanised" wire. I have usually employed them rendered "passive," in the language of Schönbein, or incapable of being readily oxidated or acted upon by fluids, in consequence of being plunged in oil after they were highly heated, or annealed, in the concluding process of their formation.[1] I have said that iron is the readiest and cheapest material for surgical sutures; and, what is of some moment under some considerations, it is also the strongest, and hence can be used of the slenderest form and least irritating size. The relative strength and tenacity of different wires is shown in the following table, given by Professor Miller, in his "Elements of Chemistry," vol. ii. p. 667.

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[1] *Schönbein's passive iron.*—"Pure malleable iron," says Dr. Graham, "such as a piece of clean stocking-wire, usually dissolves in nitric acid of sp. gr. 1.3 to 1.35 with effervescence; but it may be thrown into a condition in which it is said by Schönbein to be *passive*, as it is no longer dissolved by that acid, and may be preserved in it for any length of time without change." Dr. Graham then describes four or five different means by which iron may be rendered passive or indifferent to chemical action; as by "dipping the extremity of the wire once or twice in concentrated nitric acid, and washing it in water;" etc. etc.—(See Graham's "Elements of Chemistry," 1858, vol. ii. p. 35.)

"Taking the tenacity of lead =1, the tenacity of the different metals, after annealing, will be represented according to Wertheim's experiments, as follows :—

"Lead	1.0	Silver	8.9
Cadmium	1.2	Platinum	13.0
Tin	1.3	Palladium	15.0
Gold	5.6	Copper	17.0
Zinc	8.0	Iron	26.0"

An iron thread is thus twice as strong as a platinum thread of the same thickness, thrice as strong as a silver thread, and twenty-six times stronger than a leaden thread of the same size. The iron wire or thread which I generally use is made by Messrs. Cockers of Birmingham, and is of the gauge No. 32 of the English wire-workers' scale. The common blue capillary iron wire sold by the ironmonger answers quite well, and was entirely, at first, used by me; but it is not so soft, pliant, flexible, and easily moulded to its site in the tissues as that usually prepared for surgical purposes.

In an excellent essay on the subject of metallic sutures, M. Ollier, a distinguished surgeon of Lyons, after an elaborate investigation of the subject, draws as one of his first general inferences, "that metallic threads, when used for the reunion of wounds, are less irritating than threads of a vegetable or animal origin; they cut the tissues less rapidly; they remain for a much longer time tolerated by the tissues; occasion less suppuration along their tracks; and leave less marked cicatrices." M. Ollier also has, after much experiment and observation, adopted my conclusion, that iron forms the most advantageous of all the metallic suture-threads, in consequence of the facility of procuring it, its great tenacity, and the power of using it in the most attenuated and slender forms.[1] I have heard of various surgeons and practitioners, both at home and abroad, who now use the finest capillary iron wire as their common suture-thread.

SECTION VI.—*Proofs of the Superiority of Metallic over Organic Suture-Threads.*

This evidence has been adverted to in various places in the preceding pages. It consists of the results of observations, both on the lower animals and on the human subject.

In the summer and autumn of 1858 I made an extensive series of experiments upon the relative merits of metallic and organic sutures; and upon the relative qualities of different metallic threads. The subjects of these experiments were, for the most part, young swine; and the experiments themselves were performed for me by Mr. Edwards, Mr. Jardine Murray, and Dr. Coghill. The animals were of course always duly chloroformed. We usually made, upon the two opposite sides of the back or body of the animal, exactly corresponding wounds of various kinds, and—in ascertaining the relative properties of metallic and organic threads—we sewed one set of the wounds with metals, and the other set with silk, hemp, cotton, etc. As a general result, the contrast between wounds sewed with organic threads, and wounds of the same size and situation upon the same animals sewed with metallic threads, was most striking and remarkable. For, while the silk, hemp, or other organic sutures almost invariably began to excite inflammation and suppuration at their orifices and along their tracks, within two or three days after their introduction, the metallic sutures, on the contrary, generally remained, as it were, quite passive in the lips of the wound, and without exciting any appreciable inflammatory disturbance. The living tissues were forgetful, as it were, of the presence of metallic threads, and resentful of the presence of organic threads. In these experiments, it is to be observed, that both sets of threads were tried to be adjusted, so as not to excite any morbid excess of linear pressure, at any parts or points, upon the adjacent structures.

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[1] *Ollier.*—See his essay "Des Sutures Métalliques, de leur utilité et de leur supériorité sur les Sutures Ordinaires," Paris, 1862, pp. 54, 55, etc.

In the human subject, silk and other organic suture-threads almost always require to be cut out on the third or fourth day, in consequence of the irritation and suppuration which they are tending to excite; and, if not cut out, they usually soon eat out their own way by ulceration.

On the contrary, metallic threads may be embedded in the tissues for almost an indefinite length of time, provided they are so moulded and adjusted in the lips of the wound as not to produce at their angles or elsewhere any morbid excess of linear pressure. And when they do from this cause produce ulceration and suppuration, those processes usually stop when the excess of pressure or tension is once abated and relieved by the progress of the produced ulceration.

In man I have repeatedly taken occasion to watch the different effects of metallic and of organic suture-threads, by implanting some of these opposite kinds in the lips of the same wound. The absence or less amount of irritation attending upon the metallic thread, and the greater slowness shown in its ulcerative progress, if, under traction or pressure it produces ulceration at all, are generally very marked as contrasted with the effects and progress of the organic threads in the same wound. M. Ollier has recorded a series of cases in which he made similar comparative observations upon the course and effects of metallic and organic threads, when lodged in the lips of the same wound.

Another crucial and unassailable piece of evidence in favour of metallic as contrasted with organic threads, comes out in the fact, that some diseases or lesions, such as vesico-vaginal fistulæ, were almost never formerly cured, when silk or organic threads were used, whilst they are now almost certainly cured where metallic threads are employed. In bringing together the revivified lips of these fistulæ, organic threads nearly invariably produce so much irritation and ulceration that the complete primary union of the wound fails; whilst the primary union nearly invariably succeeds when metallic threads are employed, because these metallic threads produce little or no local irritation, and can be safely left for a week or more till entire adhesion has occurred. In the operation for vesico-vaginal fistula, success—when formerly organic threads were employed

—was a rare, a very rare exception to the general law of failure; while now, when metallic threads are used, success is the rule and failure the exception. A cure which was an accident, as it were, ten years ago, is at the present time converted, by metallic sutures, into a comparative certainty; and the profession owe Dr. Marion Sims the profoundest gratitude for the ability and success with which he has urged this view.

Perhaps we may express more clearly, in a tabular form than otherwise, the differences and advantages of the two sets of threads, the metallic and organic:—

Tabulated Contrast between the Characters and Effects of Organic as compared with Metallic Suture-Threads.

ORGANIC THREADS.	*METALLIC THREADS.*
1. Their surfaces always more or less rough.	1. Always smooth and polished.
2. They swell after their introduction.	2. They do not swell.
3. They imbibe organic fluids thrown out by the surrounding parts.	3. They imbibe no fluids, as they are impervious.
4. These fluids speedily decompose in them, and render them sources of morbific irritation to the tissues they are in contact with.	4. They remain passive and inert, as they contain no putrefying and irritating fluids.
5. Hence they soon, like miniature setons, set up, along their tracks and at their orifices, suppuration and ulceration.	5. Suppuration and ulceration are rarely excited, except when, from maladjustment, they produce angular or linear pressure, or morbid traction.

ORGANIC THREADS.	*METALLIC THREADS.*
6. Their linear irritation and attendant suppuration and ulceration usually continue till the threads cut entirely through the lips of the wound.	6. They remain almost innocuous in the lips of a wound, and if they produce ulceration from linear pressure or traction, that ulceration ceases when the pressure or traction is abated.
7. They usually require to be cut out within three, four, or five days, in consequence of the irritation which they excite.	7. If once properly adjusted, they may be left without irritation for many days, or even for weeks.
8. By their mobility and occasional relaxation they are liable to allow of partial displacements of the cohering sides of the wound, and do not ensure its necessary rest.	8. By their permanent rigidity they maintain—like splints in fractured bones—rest between the cohering sides of the wound.

For these reasons, I believe that a wound whose lips are united by iron or metallic sutures is placed by the surgeon in a better and happier condition for healing, than when threads of animal or vegetable origin are employed for the same purpose. The great and true object of surgery is to find out and adopt the conditions under which nature can best conduct her own work of union and repair. For, as was long ago observed, in true Baconian style, by an excellent writer on wounds, "the Chirurgeon is the minister not the lord of Nature, and is onely to further her designes, and to labour to remove the lets and impediments which may hinder her from attaining to her purpose, which is the restitution of the parts disjoyned to their naturall union."[1]

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[1] *The surgeon the minister of nature.*—See the above remarks in Read's "Treatise of the First Part of Chirurgerie," 1638, p. 11.

No. III.

See Page 33.

METALLIC LIGATURES—THEIR APPLICATION TO ARTERIES.

IN the "American Journal of the Medical Sciences" for May 1829, Dr. Levert of Alabama has recorded an interesting series of twenty-one experiments, which he made upon the carotid, humeral, and femoral arteries of dogs.

In five experiments he tied these arteries with lead wire; in three with gold wire; in three with silver wire; and in three with platinum wire. In all these fourteen experiments he cut the metallic ligatures off short, and allowed the wounds over them to close. In these fourteen experiments he killed and examined the state of the tied vessel from a fortnight to a month after the operation—in one case not till seven weeks, in consequence of the escape of the animal. In all of them the artery, on dissection, was found occluded, the metallic wire lying encysted and around the obliterated vessel, with little or indeed no traces of inflammation or irritation remaining. They presented, in other words, striking examples of the tolerance of the living tissues for the presence of metallic bodies. But in two cases in which he used silk in the same experiment the result was quite different. In both, the silk ligature had ulcerated through the arterial tubes, though originally drawn only tight enough to place the opposite sides of the vessel in contact without dividing the internal and middle coats. In both, the silken ligature was found loose and the centre of an abscess, in accordance with the law we have already dwelt upon, of the intolerance of the living tissues for organic bodies. In three of the five remaining experiments Dr. Levert tied the arteries with a piece of "gum-elastic" (caoutchouc?); and in the two others with "a grass ligature, such as is used for fishing-lines." In all the three experiments with gum-elastic, pus seemed to be formed around the site of the ligature; and in the two experiments with grass ligatures there was a cyst formed around them, but the inner side of the cyst was moist and uneven, and did not appear to embrace the included ligature closely, as was the case when metallic threads were used.[1]

In 1858 I had a series of similar experiments instititituted, with the view of testing the effects of metallic as compared with the organic ligatures of arteries. I was greatly indebted to a most excellent pathologist and anatomist, Mr. Jardine Murray, now of Brighton, for conducting these experiments. They were made upon a variety of different animals, as the horse, ass, pig, dog, and cat; with a variety of ligatures, as threads of gold, silver, iron—simple and galvanised—platinum, palladium, copper, and silk. The ligatures were in all instances cut off short after they were applied. The vessels ligatured with these materials were most usually the carotid arteries, but sometimes also the femoral. After deligation the arteries were examined in different cases, at different periods, varying from one day to seven months. The general results of all these experiments were quite similar to the general results already obtained by Dr. Levert. Within three or four weeks, the silk ligatures had already cut by ulceration through the arterial tube around which they were placed, and the silk loops were found lying enveloped in purulent matter, and more or less extruded from the depths of the wound towards its surface, with the view, as it were, of being ultimately thrown off altogether. In two, only, of the animals, were the metallic ligatures found surrounded with purulent matter. In one of these a wire of silver and copper was used, and perhaps the copper part of the thread was the cause of the result. In the other animal, a pig, a gold wire was put around the right carotid, and an iron wire around the left carotid artery. When the animal was killed sixteen days afterwards, the gold ligature around the right carotid was found bathed in pus, and the arterial coats were much ulcerated at the point of ligature, though a firm mass of lymph surrounded the artery, near and at this point. The iron ligature round the left carotid, in the same animal, showed complete obliteration of the arterial canal, with a mass of organised lymph effused around it. There was no pus formed round the iron ligature, but there existed an abscess superficially. As these experiments on the carotids of this animal were tried along with the insertion of a number of pieces of different metals placed in flesh-wounds on its back, it is possible that galvanic action, or the deteriorated condition of the animal's health, had something to do with these suppurative results around the ligature. At all events, out of nineteen other experiments, in which the arteries were tied with various metals, around none of the ligature loops, or tied points of the artery, was any appearance of pus seen, or any evidence of inflammation higher than the adhesive. The metallic loops remained in their original situation around the obliterated point of artery, with no apparent tendency to displacement or ejection, and the metallic threads were intimately embedded in and among the effused lymph and tissues. Even in the experiment of longest standing—that of palladium wires tied around the carotids of a cat, seven months before its death—the ligatures, surrounded by a very little lymph, were found encircling the obliterated arteries, exactly at those points where they had been applied more than half a year previously.[1]

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[1] *Levert.*—See the "American Journal of the Medical Sciences" for May 1829, pp. 17, *sqq.*

These experiments, and their results upon the obliteration of the tubes of arteries in the lower animals, by metallic threads, seemed to me to entitle us to expect, that if we applied metallic ligatures to the mouths of arteries in surgical wounds, we should in all probability be able to close them with much less attendant local irritation than when we used organic threads. But, as was remarked in 1853, by Malgaigne, in allusion to Levert's experiments, metallic threads had " never yet been tried except upon dogs."[1]

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[1] *Experiments with the metallic ligatures.*—The tied vessels in most of the preceding experiments were carefully dissected and preserved by Mr. Murray, and are now in the Anatomical Museum of the University of Edinburgh. I am indebted to Mr. Murray's great kindness for a beautiful manuscript volume containing notes of the experiments and coloured sketches and drawings of the results.

In the Edinburgh Medical Journal for July 1858, (p. 76), I have briefly reported the *first instance*, as I believe, " in which metallic ligatures were ever used in the human subject to tie the vessels laid open in a surgical operation." The operation consisted of the excision of a tumour of the mamma. I applied ligatures of slender platinum wire to the ends of the cut arteries. The wound was closed by metallic sutures, and a solution of collodion applied over it. The wound did not unite by the first intention. Its lips re-opened, and the ligatures were separated and thrown off, as its internal surface ulcerated and granulated. It healed up slowly by the second intention.

Since this first notice of the use of metallic ligatures in the human subject was published, a sufficient number of instances have been recorded in our journals, from the practice of Emmet, Holt, Letenneur, Langenbeck, and others, to prove that slender metallic ligatures—and iron wire has been the principal one employed—are perfectly adequate, as hæmostatic agents, to occlude the orifices of the bleeding arteries in amputation and other wounds ; whilst other operations, recorded by Stone, Redfern Davies, Smith, and others, prove that they are equally applicable to the closure of the larger arteries in their continuity. Their efficiency is certain, but their utility and practical applicability admit of much question. To understand this, let me observe, that metallic ligatures have been employed for the occlusion of bleeding vessels in two ways:—(1.) They have been occasionally applied with comparatively slight compressing force, their ends cut off short, and the loop of wire left, with a view to its becoming encysted within the wound; and (2.) They have been applied in other instances to the bleeding arteries, with all the usual force employed in using a silk or hempen ligature;—that is, the two internal coats of the artery have been systematically divided by them, and their elongated extremities have been left, like silk ligatures, outside the wound, with the hope that, like organic ligatures, they would speedily cut their way out through the external coat of the tied vessel. Let us briefly consider each of these two methods:—

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[1] *Malgaigne.*—See his " Manuel de Médecine Opératoire," 6th edit., p. 44.

SECTION I.—*The Ligatures cut off short, and the Loop left to be Encysted.*

In reprinting my first communication on acupressure, I added a note upon the subject of metallic ligatures of arteries, to the following effect:—"Could a round or circular—or a flattened or elongated—compress or ligature of slender metallic wire not be applied with sufficient force to close merely the bleeding arteries against hæmorrhage, *without*, however, mechanically lacerating their internal coats, or destroying the ligatured and isolated portion of the arterial tube by strangulation and gangrene? If so," I added, "such wire-compresses or ligatures—provided they were cut off short, after their application, or formed originally so

—might possibly with general impunity be left permanently lodged in the depths of surgical wounds."

When writing the above note, I was swayed by the idea, that after a circle of metallic wire was loosely twisted round the end of a divided artery, the circle could possibly be crushed, by a touch of the ends of the forceps, into an elongated or oval compress that might sufficiently occlude the tube without lacerating, or indenting too strongly, any of the tissues or coats of the artery; and I fancied that a miniature fork of stiff iron-wire might, in some instances, and under some circumstances, be pushed into the walls of the wound in such a way as to embrace and close a bleeding artery by impacting it and the surrounding tissue into the contracted angle of the fork.

We have as yet very few records of the results following the use of metallic ligatures of arteries, where they were cut off short, and left inclosed within the lips of surgical wounds. Some observations, however, published by Dr. Emmet and Mr. Holt, prove that when iron or silver wire is applied around a bleeding arterial orifice, in the usual way that circular ligatures are used, and tied or twisted, it is sufficient under this form to occlude the vessel entirely.

In a case of excision of the mamma, detailed by Dr. Emmet in the American Journal of the Medical Sciences for July 1859, he tells us he secured eleven bleeding arteries by ligatures of silver wire. Each artery thus occluded was first elevated by a tenaculum, and the wire was passed around it, crossed and drawn tight, and fixed by one twist made close to the vessel. The ligatures were then cut off as short as was deemed secure, and left to become encysted. With the hope of preventing any unequal traction at any one point, the wound, which was nine inches and a third in length, was accurately closed by a continuous and deep whip-stitch or glover's-stitch of silver wire. Primary union took place nearly throughout, but the wound at its dependent angle required to be partially separated and kept open to allow of the escape of some pus. Eight days after the operation the suture midway was found partially torn out from the upper flap, leaving a fissure which seems to have easily healed by granulation. The operation was performed on 10th March 1859, and the continuous metallic suture was not removed till April 23d, or forty-three days after its introduction. With a most careful examination at that date, "it was impossible to detect the position of a single ligature; they had become encysted, and the future must determine if they will remain so." "The slight oozing of pus, for several days after the operation, was," he adds, "scarcely in any degree from irritation of the ligatures, but in consequence of the death and separation of the portion of tissue strangulated by them"—a result, let me observe in passing, which acupressure enables us to avoid.[1]

In the same volume of the American Journal of the Medical Sciences, there is detailed a case of ligature by silver wire, of the common iliac artery, for aneurism. The operator was Dr. Stone, Professor of Surgery in the University of Louisiana. The wire was tied around the vessel like a common silk ligature, the ends cut near the knot, and the points bent down so as not to irritate the neighbouring soft parts. The knot was not drawn strongly, as is usual with the silk ligature; but only sufficiently so to stop the current of blood in the artery. The aneurismal tumour subsided very favourably, and the patient did well for several days, when dysentery set in and ultimately destroyed him on the 20th February 1859, or twenty-six days after the operation. Unfortunately there was no autopsy made to observe the manner in which the silver ligature was disposed of.[1]

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[1] *Emmet.*—See the "American Journal of the Medical Sciences" for July 1859, p. 121, *sqq.*

In the Lancet for July 23, 1864 (p. 91, *sqq.*), there are reported, from the practice of Mr. Holt of the Westminster Hospital, three cases of excision of the mamma, one of amputation of the leg, and one of amputation of the arm, in each of which that excellent surgeon used iron ligatures for the closure of the bleeding vessels, cutting them off short, and attempting to unite the wound by the first intention, so as to secure, as far as possible, the encystment of the ligature-wires. In these five cases twenty-nine vessels were tied with iron ligatures; and all the twenty-nine wire-loops continued to be retained, without, it is averred, inconvenience to the patients. At the date of the report, five months had elapsed, in one case, from the operation. Although in none of these five instances immediate primary union followed throughout the whole extent of the wound—"yet," as was observed by Mr. Holt, "a much greater portion had healed by the first intention, and much less suppuration followed than where the vessels were secured in the ordinary manner. . . There was less risk of abundant suppuration and of the occurrence of pyæmia than where the hempen ligature was employed. The surfaces of the wound were likewise kept in undisturbed approximation; the patient was saved the pain of removing the ligatures—a pain occasionally very severe; the suppuration was infinitely less; and in favourable cases there were great probabilities that immediate union might be secured through the entirety of the wound, the retention of the wire ligature not in the least degree militating against such a result, or giving the slightest inconvenience either immediate or remote."

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[1] *Stone.*—See the "American Journal of the Medical Sciences" for October 1859, p. 570.

Bright as this picture seems, there is some darkness in the background. For though, in accordance with the tolerance of the living structures for metallic bodies, the metallic loops may long remain encysted and embedded in the tissues of the ancient wound, yet, by their mere mechanical pressure and situation, they will no doubt be liable, from time to time, to give annoyance and trouble to the patient, particularly when pressed or impinged upon. Thus, Mr. Thomas Smith states, under the article "Sutures," in Holmes' System of Surgery, that three months after a fine silver ligature had been applied to the radial artery, he was obliged to cut it out, "on account of the inconvenience it caused the patient."[1] In this case there was required, what would doubtless be required in others, a second operation to remove the effects of the first; and, perhaps, in some instances, a succession of small and recurring incisions and extractions might be needed, to remove the different loops left by one antecedent operation. All such mischances, however, are avoided, when the bleeding vessels are closed by acupressure-needles—these needles being removed entirely from the wound within one, two, or three days after they are applied.

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[1] *Smith.*—See Holmes' "System of Surgery," vol. iii. p. 15.

SECTION II.—*The Ligatures left elongated for Disjunctive Ulceration, and Withdrawal.*

In the cases already referred to under Section I., the metallic threads were applied so as not necessarily, I believe, to induce division of the two inner coats of the vessel and subsequent strangulation of the external coat at the point ligatured. In other words, they were not pulled so strongly as to produce, by their constriction, mortification and sloughing of the vessel at the ligatured point—as is systematically done when ligatures of silk or hemp are employed (see Chapter IV.) But some surgeons, when using metallic ligature-threads, have drawn them with the same force and the same effects as ligatures of animal or vegetable origin. For instance, in a case of Elephantiasis Arabum, in which Mr. Redfern Davies tied the tube of the popliteal artery with silver wire—to cut off the main arterial supply of blood to the limb—the ligature came away on the twenty-first day, and the result was an almost complete diminution of the limb to its natural dimensions.[1]

[1] *Redfern Davies.*—See his paper "On Silver Wire Ligatures," in the "Lancet" for February 28, 1863, p. 233.

Again, Dr. Letenneur, in two amputations—one of the arm and the other of the thigh—tied tightly all the bleeding vessels with silver wire. The wires became loosened and detached, he avers, about the same time as organic ligatures do; the ligature of the humeral coming away on the ninth day, and that of the crural on the eleventh, and those upon arteries of less volume on the fifth. In relation, he adds, to the question of primary union, the metallic threads did not seem to him to be superior or inferior to ordinary threads of silk or hemp.[1]

As a general rule, however, it will, I believe, be found that tightly-drawn metallic ligatures separate much more slowly than organic ligature-threads. Dr. Martin has described, in his thesis, two amputations in which Professor Langenbeck closed the bleeding arteries with iron threads.[2] In one of these—an amputation of the thigh—he tied the femoral and four other vessels with iron wire. One ligature was removed on the twelfth, another on the twentieth; and the remaining three on the twenty-second day after their insertion. In another case of amputation of the leg, seven vessels were tied with iron threads. They were not separated till from the twenty-fourth to the thirtieth day after the operation. Some of these ligatures, I am informed by Dr. Martin, ulcerated through, and came off spontaneously, like silk ligatures. Others of them required to be mechanically withdrawn. Both the amputation cases recovered, and this fact was considered as especially deserving of notice, for at the time almost every amputation case in the Hospital was seized with fatal erysipelas or pyæmia. It is the more interesting when we conjoin it with a similar remark of Mr. Holt's, in regard to two cases of amputation in the Westminster Hospital, in which he used iron ligature-threads. In these cases, he says, it appeared very probable that the "non-irritation of the wound had prevented any unfavourable result, the hospital being, at the time of the performance of the operations, in an especially unhealthy state, from the presence of hospital phagedena, which had attacked many of the cases of ulcers and wounds."[1]

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[1] *Letenneur.*—See the "Gazette Hebdomadaire," 21st Feb. 1862, p. 119.

[2] *Martin.*—See his dissertation entitled "Ansa Fili Metallici, Nova Methodus Hæmostatica," Berlin, 1861, pp. 12-17.

In a communication on the substitution of iron wire for thread and silk as ligatures for arteries, inserted in the "Lancet" for May 10, 1862, p. 486, Mr. Nunneley of Leeds suggests, that iron threads, when used as ligatures for arteries, should be sufficiently fine, strong, and flexible; and for this purpose he advises the thread to be made as small and capillary as No. 37 and No. 42, or No. 43, of the English wire-worker's scale. Both of these kinds will be found, he says, "to cut well through the inner coats of a vessel, leaving the outer one entire, upon which the wire holds well." The iron wire, No. 32, which I have long used and recommended for sutures, will be found quite sufficient also for ligatures; but a finer and more slender thread may answer still better for both purposes. In fastening metallic ligatures, it is as well not to use the double knot, but only either a twist or two—or a single knot followed by a twist or two—to fasten it.

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[1] *Metallic threads as preservative against hospital erysipelas, etc.* —See Mr. Holt in the "Lancet" for July 23, 1864, p. 92.

The observations which we have adduced in this Appendix upon the subject of metallic ligatures, seem to entitle us, in the present state of our knowledge, to draw the following general inferences :—

1. Metallic ligatures are, as hæmostatic agents, easily applied, and appear as secure as silk or hempen ligatures.

2. They seem to have no tendency to be followed by secondary hæmorrhage or other special evil consequences.

3. They may be applied, either to shut up the tubes of large arteries in their continuity, such as those going to aneurisms, or to close the bleeding mouths of vessels laid open in surgical wounds.

4. In both situations they seem to produce markedly less irritation and inflammation than organic ligatures.

5. They may be applied slightly, so as merely to close the artery without injuring its tissues—their ends cut off, and their loops left to be embedded or encysted in the tissues or structures of the wound.

6. But, under this management, the embedded or encysted loops may require to be subsequently cut out and extracted in consequence of mechanical annoyance and disturbance resulting from their presence.

7. They may be applied tightly, just as silken ligatures are now, to divide at once the two internal coats of the artery, and strangulate the third—the elongated ends of the ligatures being left out long, that they may be withdrawn after they have ulcerated through the ves

8. But, under this treatment, they strangulate and slough the ends of the artery, as silken ligatures do, have all the disadvantages of a silken ligature, and have the additional objection of being longer in ulcerating and cutting through the arterial tube.

9. In the present state of our knowledge there is one set of conditions in which metallic ligatures are probably to be preferred—namely, where deligation is employed by the operator, and where he determines to leave the ligature *permanently* within the body. In cases, for example, of operation for strangulated omental hernia, when a suspicious or gangrenous part is removed, there is bleeding sometimes from a vessel or two, and ligatures cut off short are sometimes applied and allowed to pass backwards, with the omentum, into the abdomen. The same happens occasionally in cases of ovariotomy, both with the vessels of the adherent omentum, and with those of bands of false membranes that require to be divided. In these circumstances the deligation of the vessels, with a tie or twist of very slender iron or silver wire, is undoubtedly attended with less risk and danger than the employment of an organic ligature.

When, in 1858, I commenced the use and study of metallic ligatures, I entertained the opinion that their employment would be as superior to organic ligatures as suture-threads of metal were to suture-threads of silk or flax. It will be seen, however, that I have been led to conclusions on the subject which I did not then anticipate—the supposed advantages belonging to removable needles and not to fixed metallic threads.

No. IV.

See Page 68.

CLOSURE OF ARTERIES BY ACUPRESSURE—ITS PATHOLOGICAL MECHANISM.

THIS volume and its appendices have already so infinitely exceeded the limits originally intended for them, that I have no space left for the discussion of the mode or modes in which divided arterial tubes are obliterated, when their mouths are closed by the action of acupressure-needles. The discussion, historically, would have necessarily involved a consideration of several subsidiary matters of moment;—as the relative pathological mechanism and method of closure of arteries by the modern small round, and by the old large and flattened ligatures; the effects of the temporary arterial ligatures of Travers, Roberts, Cline, Palletta, and Giuntini, and of the compressing cylinder or bolster of Scarpa, as used and modified by himself and by Uccelli, Vacca Berlinghieri, Morigi, and others; and the modes by which arterial tubes are flattened and closed by semicircular threads and metallic clamps or the "presse-artères" of Deschamps, Percy, Dubois, Crampton, Flajani, Assalini, Köhler; etc. etc.

Sixty years ago, in the Edinburgh School of Medicine, Professor John Thomson taught, and his pupil Dr. Jones tried, at his suggestion and with his assistance, to prove experimentally, that when we use a round slender thread to tie an artery with, we ought always to pull it so tight that by its application and constriction the two internal coats of the artery are mechanically cut through.

It is well known that this plan is the one almost universally-acted on by English surgeons at the present day—and I have referred to it throughout the present work as the one generally adopted and followed. The principle, however, of the necessity and propriety of dividing the two internal coats of the artery, by the mechanical constriction of the ligatures used, has been much questioned by several leading Continental and American surgeons. Before the time of Dr. Thomson's teaching and Dr. Jones's publication, the professed object of the surgeon in deligation, was *not* to injure, damage, or cut through, in any way, any of the coats of the artery, but merely to place their lining membrane in contact or apposition, by flat broad ligatures, tapes, compresses, presse-artères, etc.[1] The ligature, observes one of the greatest living authorities in surgical pathology in America, Professor Gross, " is drawn with sufficient firmness to divide the inner and middle tunics, if the artery be one of large size, or even of medium caliber; while, in the smaller branches, *mere apposition* of the opposite surfaces will suffice."[1] But within the last four years acupressure has proved, by the most ample and abundant experience, that mere apposition is sufficient to close the largest arteries laid open in surgical operations as well as the smallest, and that, for the most complete and permanent occlusion of the vessel, this apposition need not be continued, as a general rule, above one, two, or at most three days.

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[1] *Non-necessity of the division of the internal coats of the artery in deligation, etc.*—The late very distinguished Irish surgeon, Sir Philip Crampton, published some interesting observations on aneurism, and on the obliteration of arteries, in the "Medico-Chirurgical Transactions" of London for 1816 (vol. vii.), in which he expresses opinions different from those of Dr. Thomson and Dr. Jones. From a variety of observations and experiments upon the arteries of men, as well as animals, he endeavours to show:— "1. That the obliteration of an artery can very certainly be effected, independently of the rupture or division of any of its coats. 2. That this operation of the ligature, so far from being

Before occluding any arteries in the human subject by acupressure, I satisfied myself by seeing the results of metallic ligatures applied so as merely to close tubes of arteries—without mechanically injuring or cutting them—that the mere apposition of the inner wall of the artery, which the acupressure-needle induces, is quite sufficient, as a hæmostatic means, for the largest arteries in the human body; and I further found, that by acupressure alone I could close such a very large vessel as

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essential to the process, not unfrequently defeats it" (p. 344). He further argues, in language which appears to me to apply strongly to the pathology of acupressure:—" 3. That a very moderate degree of irritation, applied to the external coat of an artery, aided by a sufficient degree of compression to bring its internal surfaces into contact, is sufficient to effect the obliteration of the canal. 4. That the permanent obstruction of the canal may be effected by such a process, in a period not exceeding twenty-four hours" (p. 351).

[1] *Gross.*—See his " System of Surgery," 2d edit., vol. i. p. 695

the carotid artery in the horse. No sufficiently extensive series of experiments upon the lower animals, or of observations on the human subject, has yet been collected together, to show the whole pathological mechanism by which arteries are closed when acupressure is used; but no doubt some one, far better fitted for the inquiry than I am, will betimes supply the deficiency.

The professed aim and object of the surgeon, when he divides the two internal coats of a bleeding artery by the ligature, is to produce a raw wound at the constricted point in the *interior* of the artery, and the sides of this raw wound are made to cohere by the resulting inflammatory effusions within and around the vessel. Artificial inflammation—and that inflammation pushed onwards, as we have seen in Chapter IV., to the higher stages of ulceration, suppuration, and mortification—constitutes the pathological mechanism by which he systematically occludes every bleeding vessel which he ties. But open arteries do become closed and obliterated without inflammation. We have examples of this non-inflammatory occlusion of these vessels in the spontaneous closure of some small arteries in almost every surgical wound, without deligation or torsion; and in the occlusion of the mouths of the numerous utero-placental arteries after parturition. Is the closure of bleeding arteries by acupressure, altogether independent or not of the excitation of inflammation?

No. V.

See Page 86.

WOUND-LUTES—NATURAL AND ARTIFICIAL (COLLODION, ETC.)—AND THE CONVERSION OF EXTERNAL INTO INTERNAL WOUNDS.

AMONGST surgical wounds and solutions of continuity, there is a division of very great importance—namely, into (1.) those that are *Internal*, shut, or closed; and (2.) into those which are *External*, open, or exposed.

In the first division, the site of the wound is subcutaneous, the skin remaining entire. In the second, in addition to some internal solution of continuity, there is an external division of the skin also, leading down into the internal wound. In the first, the wound or solution of continuity is protected from any contact with the air. In the second, it is exposed to contact with the air, and the constituents which naturally compose it, as well as to any foreign bodies—whether mechanical, or chemical, or organised (see p. 397)—which are actually present in it.

We have examples of the first class of solutions of continuity—or of *Internal* wounds—in simple fractures of bones; in the tearing of capsules, ligaments, and tissues produced by common dislocations; in the accidental lacerations of tendons; and in the large ecchymoses that often form subcutaneously from the tearing of blood-vessels and other tissues in consequence of blows, sprains, etc.

We have examples, again, of the second class of solutions of continuity, or of *External* wounds, in compound fractures and compound dislocations, and in all surgical injuries and wounds—whether accidental or artificial—where the skin is divided, and the division of tissues proceeds from without inwards.

The vast difference, pathologically and practically, between these two classes or divisions of wounds, was observed and taught by John Hunter. "The injuries of the first division," says he, "in which the parts do not communicate externally, *seldom inflame;* while those of the second commonly *both inflame and suppurate.*" In this great generalization Mr. Paget—the first of living surgical pathologists—truly observes: "Hunter has embodied the principle on which is founded the whole practice of subcutaneous surgery; a principle of which, indeed, it seems hardly possible to exaggerate the importance."[2]

In subcutaneous surgery[3]—including in its various

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[1] *Hunter.*—See his "Works," by Palmer, vol. iii. p. 240. M. Guérin of Paris enunciates the same proposition as follows:—"That all wounds made under the skin and kept from the contact of the air neither inflame nor suppurate, and organization takes place immediately."—(See his "Essais sur la Méthode Sous-cutanée," Paris, 1841, p. 2.)

[2] *Paget.*—See his "Lectures on Surgical Pathology," 2d edit., p. 129.

[3] *Subcutaneous wounds.*—The principle extends in various

modifications the division of tendons, muscles, and sometimes of other tissues—and likewise in simple fractures and dislocations, etc., the process of organic reunion and repair goes on among the internal wounded and divided parts without any symptoms of inflammation and without suppuration, provided the parts are placed or kept for some days in a state of perfect quietude. On the contrary, in all external solutions of continuity, where the wound is allowed to remain unclosed, and in compound fractures[1] and dislocations, inflammation and

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directions. An external wound into the knee-joint, for example, is far more perilous than an internal wound of the same joint, and hence the origin and explanation of the relative success of the operation proposed by M. Goyrand for the extraction of loose cartilages by successive subcutaneous incisions. It extends also in a more limited degree to external cutaneous, as compared with internal mucous wounds. Hence, perhaps, one source of the superiority and greater safety of Messrs. Holt and Thompson's plan of the internal splitting or division of urethral strictures as compared with the external perineal section of M. Tolet and Mr. Syme. Perhaps the success attendant on the operation for vesico-vaginal fistula is partly due to the same cause (see *ante*, p. 116). The wound left after parturition, on the interior of the fundus and cavity of the uterus—by the laceration from it of the whole system of the utero-placental arteries and veins, and by the separation of the external layer of the decidua—heals with such comparative safety and speed and certainty in consequence of this law. Nature, besides, is allowed to manage the wound in the interior of the uterus solely in her own way. If this puerperal wound could only have been reached by art, what an interminable and frightful array of dangerous washes, lotions, ointments, liniments, salves, cerates, etc., for it, would the records of obstetric medicine have possessed by this time!

[1] *Treatment of comminuted fractures as closed or subcutaneous wounds.*—Wonderful recoveries sometimes occur when commin-

suppuration are almost constant and inevitable results unless the cutaneous wound be small and immediately closed. But the successful repair of all wounds by primary union, depends greatly upon the absence of any excess of inflammation. "The reparative process in wounds, the result either of accident or surgical opera-

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uted fractures are treated by perfect quietude and rest, if the skin is not broken; or, if broken, is at once closed and sealed up. As an example, let me here cite the following case of subcutaneous injuries implicating several bones and joints. It was under the care of Mr. Hancock, surgeon to the Charing-Cross Hospital. I quote the case in the words of Mr. Adams. "A boy, æt. 12, had his left hand crushed by machinery; it was drawn in between heavy rollers, which were set at one-sixth of an inch apart, as I proved by measuring a flat piece of wood placed between them. All the phalanges and some of the metacarpal bones were more or less crushed, and the hand was perfectly flattened. Fortunately only a very small wound existed, on the inner side of the index finger. From this circumstance Mr. Hancock determined not to amputate, but to try and save the hand, though the severity of the injury gave little hope of success. However, the case went on well. Four months after the accident, the fingers had nearly regained their natural form, and slight motion existed in all the joints. The absence of an open wound communicating with the comminuted fractures, determined the practice in this case; and, therefore, to the subcutaneous nature of the injury is this poor boy indebted for the possession of his hand."—(See Mr. Adams' excellent "Sketch of the Principles and Practice of Subcutaneous Surgery," 1857, p. 10.) This and other similar cases inevitably force upon the mind the belief that, in times past, many an injured finger, hand, and limb have been summarily and recklessly lopped off by the amputation-knife, which might, perhaps, have been spared and saved, if the "Preservative Surgery" of subcutaneous and of closed wounds had been duly acknowledged and acted upon.

tions, is," says Mr. Adams, "more perfect in proportion to the absence of inflammation; and the danger arising from wounds very much depends upon the extent of the inflammatory complications."[1] We eschew these obstructive inflammatory complications when the wound is internal or shut; we encounter them in greater or less severity when it is external and left unclosed—for then every point or part of the wound which is not in contact with an opposed point or part invariably suppurates before it can heal.

One great object of the Chirurgical Art is, in all common and operative surgical wounds, to convert the existing external or open wound, which is unavoidably liable to the deleterious effects of inflammation and suppuration, into a safe internal, shut, or closed wound, where the processes of speedy healing and repair might go on by immediate reunion or primary adhesion. It is in order to effect this conversion, as far as possible, of the external or open wound into the form of the internal or shut wound, that we bring the walls and lips of the wound together as accurately and completely as we possibly can, by unirritating metallic sutures.

Smaller and more superficial external wounds are often converted into shut wounds by Nature herself, by some of her own healing processes; and when these are sufficient, there is no call whatever for Art to interfere.

In some incised wounds, for example, she speedily cements and solders their lips together by a wound-lute or crust of coagulated blood—a means in the preservative surgery of nature which is often superior to any kind of surgical appliances or dressings for changing an open into a shut wound.[1]

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[1] *Adams.*—"Sketch of Subcutaneous Surgery," p. 22. See also Mr. Paget's "Lectures on Surgical Pathology," pp. 215, 216; and the opinion of Mr. Syme at p. 267, etc., *ante.*

Again, in most wounds, the surfaces of which are not brought together till *after* the bleeding has ceased, nature covers their lips—after they are placed in due approximation to each other—by an exudation of sero-sanguinolent fluid, the speedy evaporation of the thinner part of which leaves a fibrinous lute or crust. In wounds whose lips are conjoined by sutures, this coagulating cement is soon deposited along their united edges, allowing any reddish serous discharge that may be oozing from the depths of the wound (see *ante*, p. 106), for the first day or two, to escape by a valvular-like exit, and yet sealing up, as it were, and closing the cavity of this wound itself. The presence of this crust is,

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[1] *Coagulated blood as a wound-lute.*—In illustration of the value of this natural wound-lute, let me adduce a case related by Dr. Macartney. A gentleman was attacked by a band of robbers, and received seven wounds, inflicted by bayonets, and made in the side and arms. The gentleman was on a journey to the south of England, and he travelled on as rapidly as possible—never staying on the way to have his wounds examined—nor did he undress himself lest the clotted blood should be unsettled and the parts consequently irritated. On the gentleman's arrival at Margate, Dr. Macartney examined his wounds, and was, he adds, "surprised to find they had all perfectly healed and cicatrized under the crusts of dried blood, with the exception of two bayonet stabs in the forearm, which contained a very little pus, probably on account of their situation, which subjected them more to motion than the others, from the unavoidable use of the hand."—("Treatise on Inflammation," p. 208.)

I believe, highly beneficial and reparative, and hence I have ventured to advise that water-dressings be not applied at once, as is often done, to recently closed wounds, because they tend to loosen and dissolve this crust,[1] and designedly unmake the wound-lute which nature is designedly making (see *ante*, p. 117).

We have been speaking hitherto of linear or incised external wounds; but even in the case of denuding cutaneous abrasions, and flat superficial wounds, the crust formed over them by nature forms the best and happiest dressing, if it be left on them totally and entirely undisturbed till it fall off of itself, which is often a period of many weeks. This practical fact is well known with regard to superficial denuding abrasions of the shin, forearm, etc., and has sometimes formed a principle which has been acted upon in the management even of large wounds. For example, in a very extensive gaping flat wound, produced by the amputation of a mamma and the removal of much skin, Mr. Wardrop left the crust or scab of blood that formed over it entirely uninterfered with, and when it fell off, after more than thirty days, the cicatrization was almost complete.[1] In these, and indeed in all forms of wound-lutes and crusts, all local, mechanical, and other causes of irritation and inflammation, must be carefully avoided, as the excitation of suppuration beneath the lute or crust, will more or less interfere with the healing of the wounded surfaces.

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[1] *Artificial formation of crusts.*—In cases of fresh wounds, crusts are formed of hardened blood or fibrin; and in cases of granulating wounds and recent or chronic ulcers, of pus. To make them artificially of any of these substances, M. Guyot at one time proposed to expose all wounds and ulcers to hot dry air, that a crust might thus be rapidly formed over them. A stream of cold air from a bellows will be found to answer equally well, or still better, in promoting the same object, especially in cases of recent wounds. Some surgeons use chemical means to induce the deposit and formation of the crust, particularly in instances of granulating wounds and ulcers. Touching the wound gently with nitrate of silver, sulphate of copper, etc., will sometimes effect this object, or still better, dusting it with some layers of bismuth powder. Others use for the same purpose mechanical measures, such as a layer of the scrapings of surgeon's lint, starch, chalk powder, etc. The formation of a wound-lute of coagulated blood is tried to be promoted by some surgeons, by placing

If, in an incised superficial wound, metallic stitches are not deemed necessary or proper, and if the natural wound-lutes, or incrustations of blood, or of fibrin, are not strong enough to be trusted to, or not present, then, perhaps, an artificial crust or lute may be applied to close and glue up the lips of the open wound. Plasters of various kinds, spread on leather, linen, ribbon, etc., have been used from the earliest days of surgery, for the purpose of approximating and bridging over the edges of the wound, without, however, directly applying a lute to their line of union. But plasters, particularly when

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a piece of charpie or rag, steeped in fresh blood, over or along the mouth of the wound. Thus, in treating of compound dislocations and fractures of the ankle-joint, Sir Astley Cooper observes:— "When the bone has been reduced, a piece of lint is to be dipped in the patient's blood, and applied wet over the wound, upon which the blood coagulates, and forms the most natural, and as far as I have seen, the best covering for the wound."—(See his "Treatise on Dislocations and on Fractures of the Joints," 2d edit., p. 255.)

[1] *Wardrop.*—See the "Lancet" for August 17, 1833, p. 652

applied very near to each other, so generally overheat, irritate, and constrict the lips and vicinity of the wound, and hence tend so much to produce inflammation in it, that many of our best surgeons have discarded the application of them in recent wounds. Are there no simpler and safer means of gluing together the lips of external wounds, and so far converting them into internal wounds? Is there nothing which we can lay upon their united cutaneous surfaces — fluid at first like nature's own wound-lutes of coagulated blood and fibrin —which might, by evaporation, speedily become solid, and so coherent as readily to keep the edges of the wound in accurate contact?

In a communication on this subject in June 1848, to the Medico-Chirurgical Society of Edinburgh, entitled " On Solutions of Gun-cotton, Gutta-percha, and Caoutchouc, as Dressings for Wounds," etc., I stated the results of a number of experiments on these materials, as lutes or crusts for the closure of some wounds, pointed out the solubility of gutta-percha in chloroform, and ventured to observe :—

" It seems not at all improbable that another step in advance will betimes be effected, and that surgeons will be enabled to apply to the wound, after its edges are brought in contact, some material or other, which, like an artificial plasma or lute of coagulable lymph, will at one and the same time serve the following purposes :—

" 1. It will be sufficiently strong and adhesive to retain the edges of the wound together, without the irritation sometimes following the use and removal of sutures or pins.

"2. It will serve as a perfect dressing to the wound.

"3. It will, however, not be soluble in water, or be easily removed, and hence will enable the surgeon to apply cold, etc., to restrain and modify the action in the wound, if required.

"4. Though insoluble in water, the material used must be soluble in some menstruum that is easily and readily vaporized.

"5. It will be applied in a fluid or semi-fluid form, and be thus capable of adapting itself to any irregularity in the edges of the wound, or in the neighbouring cutaneous surface; the fluid part evaporating easily on exposure—and a solid tissue or substance, possessing sufficient tenacity, adhesiveness, and insolubility in water for the above purposes, being left like a plaster on the edges of the united wound."[1]

When one or two drops of collodion (a solution, as is well-known, of gun-cotton in sulphuric ether) are spread out as a thin layer upon the skin, the ether rapidly evaporates and leaves a thin, semi-transparent, and strongly adherent lute or film, impervious to air and water, and incapable of being washed off. The same occurs when a solution of gutta-percha in chloroform is used in the same way—only the evaporation of the chloroform is slower, and the film somewhat thicker. Dr. Bigelow and Mr. Maynard suggested the application of collodion as a dressing for recent wounds in its pure form. But a layer of pure collodion, when applied to the skin, crisps and contracts so very much within a short time, as to constrict greatly the parts over which it is applied—producing sometimes considerable dragging, irritation, and redness, around its whole circumference. In this form it usually proves more hurtful than useful. When applying it, however, to ulcers and fissures of the nipple, and to some cutaneous eruptions and slight recent wounds, I have found that the addition to each half-ounce of the ether of twenty or thirty drops of castor-oil modifies its qualities most favourably, by destroying its contracting and constricting tendencies. If ever used to recent wounds, it should be employed in the form of a mixture with oil.

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[1] *Qualities of wound-lutes.*—See the Edinburgh "Monthly Journal of Medical Science" for July 1848, p. 49, *sqq.*

Most of the qualities which I have pointed out for a wound-lute, in the extract already given (p. 545), are possessed both by collodion and by a saturated solution of gutta-percha in chloroform—with the exception of the menstrua forming them being perhaps too irritating in their action. If the first layer spread be very slight, the difficulty is in a considerable degree overcome; or perhaps a very thin under-layer of oil or glycerine[1] would serve better. There is, however, a still stronger objection to their employment, in the fact that both applications are liable to close up the lips of the wound so strongly and completely, that the natural serous or sero-sanguinolent discharges from its interior, are apt to be retained and accumulated, with deleterious effects, within the cavity of the wound. A little care, perhaps, in their application would avert this, by leaving due interspaces. The application is sometimes rendered difficult by the presence of moisture or blood, which prevents the collodion adhering as it consolidates over the site of the wound; and, in such circumstances, it is perhaps best applied by dipping a piece of charpie, or riband of cotton or lint, in the collodion, and bridging the wound over with it. But I doubt now—after some experience in the matter—if we are to expect much, or any practical benefit from the employment of any artificial wound-lutes as yet known, in any wounds except those which are very shallow and superficial. After all it is to be remembered, that in these, as in the largest wounds, our great object is to close, and keep closed, their surfaces by any unirritating means, for two or three days, till their natural primary adhesion occurs; and that nature "rarely faileth in acting *her* part," as Richard Wiseman writes it, "if we perform *ours* in retaining the lips close together, and defending them from fluxion." "But," he farther states, "nature hath nothing to doe here in bringing the lips together; *that* is the work of the Chirurgeon."[1]

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[1] *Glycerine.*—In a very able monograph on Glycerine, M. Demarquay has pointed out its value as one of the best protective cicatrizing and detergent dressings for wounds, particularly when healing by the second intention.—(See his memoir, "De la Glycérine, de ses Applications à la Chirurgie et à la Médecine," Paris, 1863, p. 96, *sqq.*)

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[1] *Wiseman.*—See his "Chirurgicall Treatises," pp. 341 and 362.

No. VI.

See Page 117.

CARBONIC ACID TO WOUNDS—ITS LOCAL ANÆSTHETIC, CICATRIZING, AND DETERGENT POWERS.

IN Chapter VIII. I have attempted to show that the special "work of the Chirurgeon"—namely, the placing and keeping of the surfaces and sides of a wound accurately in contact—is perhaps best effected by careful and multiplied metallic stitches; and that, as a general rule, after these stitches are introduced and adjusted, we should apply nothing—absolutely nothing whatever—in the way of external dressing. But I have added, that if, after a time, the lips of the wound threaten to become red or inflamed, we may, in order to reduce this irritation, have them bathed or irrigated with cold water, or still better with cold air—a stream of the latter from a pair of bellows being apparently as sedative and as grateful as an application of the former, and effected, too, without the mischance of disturbing and destroying the wound-lute or crust, which nature at the time is depositing on the surface or along the line of the wound. Carbonic acid gas, I remarked (see *ante*, p. 117), is still more sedative in its local application to abraded and wounded surfaces.

In an article on carbonic acid gas as a local anæsthetic, etc., published in 1856 (see my "Obstetric Works," vol. ii. p. 769, *sqq.*), I endeavoured to point out the sedative and therapeutical effects of this gas, in a variety of ailments, when applied to the different mucous membranes of the body—as that of the stomach, intestines, uterus, bladder, throat, lungs, eye, etc.; and I attempted to prove that, in ancient times, it had been successfully used, under some disguised forms, by Hippocrates, Paulus Ægineta, Rueff, Paré, etc.; whilst in modern times, in another half-occult form, it had, as thrown off in great quantity at the German baths of Neuheim, Marienbad, etc., proved a successful local application in various local diseases.

In the same communication it was attempted to be shown, that *surgically* the local application of carbonic acid gas had, according to the testimony of Dr. Ewart, Dr. Percival, etc., proved of much service in some cancerous sores, in annulling and alleviating the pain attendant upon them; and in correcting, as a detergent, the fetidity of the discharges, and in temporarily contracting and cicatrizing some of the ulcers. Dr. Nooth has published evidence to the same effect. Further, the experiments of Dr. Ingenhouz and Dr. Beddoes were adduced by me to show, that when the cuticle was raised by blistering, and the blister opened, the smarting pain which almost immediately results was speedily reduced by plunging the denuded surface into carbonic acid gas, but returned when the denuded skin was again exposed to the atmosphere:—"If there be no source of fallacy," I added, "in these experiments, they certainly point to one kind of important improvement in the treatment of some painful burns, *wounds*,[1] etc. For they appear to me to suggest the possibility of the suffering which is attendant on such injuries being controlled and cancelled, by keeping the pained parts in contact with carbonic acid, or with some other gas or fluid, capable of acting as a local anæsthetic. If the reports of Ewart, Beddoes, and Fourcroy are correct, we ought also, indeed, to find carbonic acid an excellent application, even as far as the mere healing and cicatrization of the broken surfaces are concerned."[1]

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[1] *Application to wounds—errors regarding the term "ulcer."*—This passage, as far as I know, contains the first suggestion of the application of carbonic acid to surgical wounds. MM. Leconte and Demarquay state, as one of the inferences from their experiments upon carbonic acid, which they laid before the Academy of Sciences, that carbonic acid seems destined, as Priestley first announced, to play an important part in the therapeutics of wounds (*L' acide carbonique semble donc appelé, ainsi que l'avait annoncé le premier, Priestley, à jouer un rôle important dans la thérapeutique des plaies*).—(See the "Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences" for 18th April 1859, tom. xlviii. p. 845.) I do not know anywhere, in any of Dr. Priestley's writings, any notice or suggestion of the applicability of carbonic acid to the treatment of wounds. He speaks of its possible utility externally in cancers and ulcers; but never, I believe, in wounds. In an important surgical work, which has lately issued from the Parisian press, there is a mistake of an analogous kind. I allude to the new and talented treatise of Professor Jobert (de Lamballe), "De la Réunion en Chirurgie." He states that the principle of the primary union and repair of the opposed sides of wounds, by merely placing and keeping them in contact, was a principle laid down by Hippocrates, at the origin of the healing art. And he appeals, in corroboration of it, to the well-known treatise Ἱπποκράτους περὶ Ἑλκῶν.—(See M. Jobert's "Préliminaires," pp. viii. and ix.) But in the last four translations of this Hippocratic treatise, three of the translators, Drs. Adams, Kühn, and Grimm, consider the work to be an essay on ulcers. One of the four, M. Littré, translates it as an essay on wounds. But even if it were this last, it certainly contains nowhere any allusion to the doctrine of healing wounds by the first intention. The nearest approach to it is in one point where it recommends, to use the words of Dr. Adams, "the mode of treating ulcers by the formation of a scab, which was much approved of by Hunter and his friend Sir Everard Home."

In his late elaborate volume upon carbonic acid and its therapeutical applications, M. Herpin states, that my researches on carbonic acid have been successfully pursued in France by MM. Follin, Maisonneuve, Broca, etc.[2] At present we refer to these researches only in so far as they relate to the surgical application of carbonic acid as suggested in the paragraph I have quoted, in relation to the treatment of wounds. A memoir on the matter, founded on numerous comparative experiments, and laid by MM. Leconte and Demarquay before the Academy of Sciences, shows that in subcutaneous—and hence we infer also in open wounds—the application of

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—(See Adams' translation of "The Genuine Works of Hippocrates," vol. ii. p. 793.) The earliest notices which I know of in Greek medical literature regarding the treatment of wounds for union by the first intention, are those remarkable passages which I have cited in a preceding page (p. 134) from Galen. If Celsus preceded him, as most medical historians believe, then the earliest notice of primary union and the healing of wounds by first intention is to be accorded to the twenty-sixth chapter in the fifth book of his celebrated Latin treatise "De Re Medicâ."

[1] *Simpson.*—"Obstetric Memoirs," etc., vol. ii. p. 777.

[2] *Herpin.*—"De l'Acide Carbonique," 1864, p. 230.

carbonic acid gas hastens, in a high degree (*au plus haut degré*) the process of reparation and healing, whilst, in a later note upon the treatment of rebellious wounds (*plaies rebelles*) by carbonic acid, they maintain that it is the most powerful agent (*le plus puissant agent*) for the cicatrization of wounds exposed to the air, when these wounds have resisted all the ordinary methods of treatment.[1]

The ancient history of general anæsthetics is sufficiently striking, and so is that of local anæsthetics. In some historical notices of the production of artificial local anæsthesia, published in the London Medical Gazette for July 1848 (p. 62), I pointed out that Dioscorides, who repeatedly mentions the induction of general anæsthesia by mandragora, states it as a matter of report, that local anæsthesia in a part may be caused by the Memphian stone. Pliny further tells us, that this Memphian stone was "a marble," and hence it was a carbonate of lime, from which of course carbonic acid could be at once eliminated by the application of vinegar or any weak acid. "For medicinal purposes," says Pliny, "it is triturated and applied in the form of a liniment, with vinegar, to such parts of the body as require cauterizing or incision; the flesh becoming quite benumbed, and thereby insensible to pain."[2]

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[1] *Leconte and Demarquay.*—"Comptes Rendus," tom. xlviii. (1859), pp. 843-845; and tom. liv. (1862), pp. 689 and 690.

[2] *Pliny.*—See his "Natural History," translated by Bostock and Riley, vol. vi. p. 328, or Book xxxvi. cap. xi.

No. VII.

See Page 385.

SURGICAL FEVER; AND WHAT SURGICAL PATIENTS DIE OF.

WE have seen (see *ante*, p. 385) that out of 153 patients who died after surgical operations or injuries at Guy's Hospital, London, Dr. Chevers found that only 18 or 19—or about 1 in every 8 of the whole deaths—were from purely *surgical* complications, such as gangrene, hæmorrhage, tetanus, etc. In regard to the other 134, I have elsewhere observed, in some published lectures on Surgical Fever:—

"If thus only so very small a proportion, therefore, of surgical patients die of fatal surgical complications, what do the great mass of them die of? They perish showing symptoms of acute fever during life, and showing on examination after death, in various internal organs, the products of acute and recent inflammation. They die of surgical fever—a disease consisting of a combination of coexisting acute fever, and acute internal inflammations—just as puerperal patients die of puerperal fever, a similar compound disease, consisting, exactly like surgical fever, of coexisting acute fever, and acute internal inflammations. Of Dr. Chevers' 153 surgical patients, 134 died of surgical fever, and presented after death recent acute inflammatory effusions and lesions in various internal organs. The relative frequency with which different internal organs and parts of the body were found attacked with acute inflammation in these 134 cases, is shown in a condensed form in the following table:

Inflammatory Lesions in 134 *Cases of Surgical Fever.*
(*From Chevers.*)

	Cases.		Cases.
Peritonitis was observed in	52	Arteritis and aortitis	4
Enteritis (excluding cases of hernia)	9	Phlebitis	3
Pneumonia and its results	47	Meningitis	27
Pleuritis	35	Cerebritis	9
Bronchitis, laryngitis, and diphtheritis	4	Cystitis	8
Pericarditis	14	Pus in muscles or joints	3
		Inflammation of tunica vaginalis	1

"When in Vienna in 1858, my nephew, Dr. Alexander Simpson, obtained access to the pathological records of the large General Hospital there, where the autopsies are made under the supervision of Professor Rokitansky, and drew up for me, from these records, some statistical tables to show the relative frequency with which the various organs and parts of the body become the seat of secondary inflammatory changes in the cases of patients dying of surgical and of puerperal fever respectively. Allow me to call your attention to this

Table showing the relative frequency with which different Organs and Parts of the Body were found to have undergone recent Inflammatory Changes in 100 *Cases of Surgical Fever.*

	Cases.		Cases.
The lungs and pleura in	69	Bladder	6
Veins	53	Liver	5
Seat of the operation or injury	40	Pericardium	4
Cellular tissue and muscles	28	Lymphatics	3
Peritoneum	16	Arteries	2
Brain and its membranes	16	Vagina	2
Bones and joints	15	Interior of uterus	1
Spleen	10	Heart substance	1
Kidneys	9	Parotid gland	1
Stomach and bowels	7	Ear	1

"The patients in whom inflammatory lesions of these various internal organs and parts were discovered after death, had been subjected to operations and injuries of all parts of the body, and of all degrees of severity, from amputation of the thigh, down to the operation for phymosis, and the simplest, most superficial wounds.

"Consider now that table of the organs and tissues most commonly affected by inflammation in cases of surgical fever, with this

Table showing the per-centage relative frequency with which different Organs and Parts of the Body were found to have undergone recent Inflammatory Changes in 500 *Cases of Puerperal Fever.*

Seat of the inflammatory lesion.	Per cent of cases.	Seat of the inflammatory lesion.	Per cent of cases.
Interior of uterus	74.4	Kidneys	3.4
Veins of uterus	69.8	Stomach and bowels	2.6
Peritoneum	64.2	Pericardium	2.4
Lungs and pleura	40.4	Mamma	1.4
Lymphatics	25.8	Fallopian tubes	1.
Ovaries	15.6	Bladder	0.8
Cellular tissue and muscles	9.2	Parotid gland	0.6
Veins other than uterine	8.0	Heart substance	0.6
Brain and its membranes	4.6	Endocardium	0.4
Spleen	4.2	Iris	0.2
Vagina and pudenda	3.8	Tonsil	0.2
Bones and joints	3.6	Larynx and trachea	0.2

"A comparison of these two tables will serve to show you how far we are justified in speaking of surgical and puerperal fever as analogous in their nature; and the difference in the frequency with which different internal organs and parts are apt to become the seat of the acute inflammatory effusions and changes in the two sets of cases, is owing mainly, if not indeed altogether, to the difference in the seat of the primary lesion; for the identity between the two diseases becomes more striking, if we compare the latter of these two tables with such a one as this:—

Table showing the relative frequency with which different Organs were found to have undergone recent Inflammatory Changes in 19 *Cases of Surgical Fever, resulting from operations and Injuries of the Pelvic Organs (including three cases of Herniotomy).*

Seat of the inflammatory lesion.	Per cent of cases.	Seat of the inflammatory lesion.	Per cent of cases.
Peritoneum . .	63.1	Liver	15.8
Lungs and pleura .	63.1	Veins	10.5
Seat of wound . .	26.3	Spleen . . .	10.5
Cellular tissue around kidneys . . .	26.3	Vagina . . .	5.3
Cellular tissue elsewhere	21.	Uterus . . .	5.3
Intestinal canal . .	15.8	Bronchi . . .	5.3
Bladder . . .	15.8	Parotid gland . .	5.3

"The proportion in which different internal organs are the seats of acute inflammatory action and deposits, is very much the same in this table as in patients dying of puerperal fever, apparently, because, I beg to repeat, the primary lesion or wound in the surgical cases included in this table was, as in the puerperal patient, in the pelvic viscera or neighbouring parts."

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[1] *Causes of death in surgical patients.*—See my "Clinical Lectures on Diseases of Women," Philadelphia, 1863, pp. 158, *sqq.;* or "Medical Times and Gazette," April 23, 1859, p. 412.

No. VIII.

See Page 399.

PROPHYLACTIC SURGERY: ITS PRACTICAL IMPORTANCE.

"THE last part of surgery, namely operations, is," observes John Hunter, "a reflection on the healing art; it is a tacit acknowledgment of the insufficiency of surgery. It is like an armed savage, who tries to get that by force which a civilized man would get by stratagem." And he adds—"No surgeon should approach the victim of his operation without a sacred dread and reluctance."[1]

Truly, when a surgeon is about to subject a fellow-being to a dangerous surgical operation, he cannot conscientiously despise a single atom of human knowledge that might give his patient a single additional chance of life. Frequently he is called upon to use his knife where, as in cases of sudden accident and injuries, there is no time for any preparatory management, or for the institution of preventative measures. But, still more frequently, the operation is for a chronic disease, or for the results of a previous injury, and he has at his command a week or two, or more, to prepare his patient's constitution for undergoing the shock and dangers of the proposed operation.

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[1] *Hunter.*—See his "Works," by Palmer, vol. i. p. 210.

The adoption and importance of such preparatory treatment is every day becoming more acknowledged by philosophical and practical surgeons, and constitutes "Prophylactic Surgery." In the lectures on Surgical Fever,[1] referred to in the last Appendix, I endeavoured to point out the importance of various measures of preventative treatment in those that were to be operated upon, and discussed, with this view, the date of operating, preparation by previous restraint of the patient for some operations, antecedent dieting, the hygienic condition of the patient in regard to purity of air,[2] etc.;

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[1] *Surgical fever.*—See the "Medical Times and Gazette" for April 23, April 30, May 14, and May 21, 1859.

[2] *Purity of air—Hospital residence, etc.*—In regard to the question lately much debated as to the air and form of hospitals, I observed, "We know that when all precautions as to placing surgical patients in abundance of free and fresh air are set at nought, and when many are crowded together into a small ward, the worst forms of surgical fever, with hospital gangrene, spread rapidly among the unhappy inmates. You can thus create and manufacture the disease almost at will, by directly disregarding and neglecting all cleanliness and purity of air; and it may yet come to be a question whether we should not give, on the contrary, our surgical patients a greater chance of escape by changing our large hospitals into villages, and the palaces of which they consist into cottages, than by adhering to the present system of erecting for their reception houses built with wards rising above wards. Perhaps, even, hospital wards get deteriorated by long use, and the emptying, cleansing, and whitewashing of them from time to time is, no doubt, a prophylactic measure of paramount importance. Old surgical hospitals, and old surgical

as also various points, influencing, in individual cases, the chances of being able to resist, or not, the perils and dangers of operative interference. After dwelling upon these, I ventured to offer the following observations upon the possible utility and importance of preventative or prophylactic medications in surgery :—

"Therapeutic prophylactic measures have also been tried, with the view of preparing surgical patients to encounter the danger of the surgical knife with increased chances of escape and safety. With this view, various tonics and alteratives have sometimes been given to surgical patients, before operations, to avert the chances of Surgical Fever afterwards. No very great or marked

wards, seldom offer such good returns from practice as newer hospitals and newer surgical wards."—("Medical Times and Gazette," for May 14, 1859, p. 490.) On the same subject, in 1848, I remarked :—"I have often stated and taught, that if our present medical, surgical, and obstetric hospitals were changed from being crowded palaces, with a layer of sick in each flat, into villages or cottages, with one, or at most two patients in each room, a great saving of human life would be effected. And if the village were constructed of iron (as is now sometimes done for other purposes) instead of brick or stone, it could be taken down and rebuilt every few years—a matter apparently of much moment in hospital hygiene. Besides, the value of the material would not greatly deteriorate from use—the principal outlay would be in the first cost of it. It could be erected in any vacant space or spaces of ground within or around a city, that chanced to be unoccupied ; and in cases of epidemics the accommodation could always be at once and readily increased."—(See the Edinburgh "Monthly Journal of Medical Science" for November 1848, p. 338 ; or my "Obstetric Memoirs and Contributions," vol. i. p. 857.)

results have hitherto attended this form of surgical prophylaxis ; and, indeed, we need the less wonder at this, seeing that these experiments have never yet been conducted on any very extensive scale. But I confess that it has always appeared to me that this line of inquiry was—in relation to surgical operations—one of the most important to which the 'young surgery' of these times could turn its attention.

Look at these two patients lying next bed in the same ward; they are nearly of the same age, and were a few days ago operated on by the same surgeon. One of them had his thigh amputated, and though thus the surgeon's knife has produced upon his body a mighty mutilation, and left upon it a vast surgical wound, yet his pulse is quiet, his skin is cool, and, in short, constitutionally he seems perfectly well. The other patient, lying within a few feet of him, has merely had a small and simple subcutaneous tumour removed from the surface of his leg—an operation requiring infinitely less cutting, and leaving an infinitely smaller surgical wound. But his pulse is ranging up to 130 or 140, his skin is alternately burning and perspiring, and altogether he is suffering under a dangerous, and probably a fatal attack of Surgical Fever. Now, there *must* have been something different in the two constitutions of these two men[1] before operation; the existing state of constitution in the first patient rendering him *not liable* to surgical fever, even after one of the severest operations in surgery; the existing state of constitution of the second patient rendering him, on the contrary, *liable* to be attacked with that disease after a very small wound, and a slight application of the surgical knife.

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[1] *Something different in the two constitutions of these two men.*—By this I mean something different at the time of operating—not different in their constitutions radically and fundamentally For, in the history of cases of surgery, we constantly see this that individuals whose constitutions to-day will not allow them

The great question for solution is, could we by any ARTIFICIAL means, adopted beforehand, produce in all our surgical patients that defiant or resistant state of the constitution, which enabled that first patient with the amputated limb to bear with impunity, and without danger from surgical fever, the severe surgical operation to which he has been subjected? Or, in other words, could we by any antecedent means so change, improve, and fortify the existing state of constitution of the second patient, as to make him bear with impunity the application and effects of the surgeon's knife? The problem is a practical problem, not so impossible in its nature and principles as to prevent us making earnest and anxious attempts at its solution; and, whoever could successfully solve it for the prevention of Surgical Fever in surgical patients, or, let me add, for the prevention of that analogous disease puerperal fever in puerperal patients, would, in my opinion, make ONE OF THE GREATEST ad-

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to have a small tumour removed without the supervention of surgical fever, may have amputation or lithotomy performed upon them a few months before that date, or a few months after it, without any threatening of surgical fever at all. In other words, it is, I repeat, a difference in the constitution of the patient *at the time*, that predisposes him for, or predisposes him against, an attack of the disease.

vances that could possibly be effected at the present hour in the onward march of medical science; because it is one that would probably save more human lives in surgical and obstetric practice than any other one single discovery.

Various alteratives and tonics, as I have stated to you, have been tried, with this prophylactic intention, but none of them on any great scale, or with any great degree of perseverance. With this view, patients have, preparatory to operations, been placed upon disulphate of quinine, chlorate of potass, etc. Mr. Hamilton Bell, and other practitioners in Edinburgh, have of late years been led to place great reliance upon the curative powers of tincture of the muriate of iron in cases of erysipelas. In many points, there is a strong analogy, though by no means an identity, between the compound febrile and inflammatory character of surgical fever and of erysipelas. Arguing thus, I long thought that muriate of iron, if given as a prophylactic against surgical or puerperal fever, might probably contribute to prevent the constitution being attacked with these diseases; seeing that it was one of the simplest means of getting rid of the analogous erysipelatous affection after it had once begun; depurating the blood—probably as a renal purgative—of morbific azotised and effete matters, whilst at the same time it was one of the best forms of tonics. For about eighteen months before he retired from the position of operating surgeon to the Royal Infirmary, my friend Dr. Dunsmure was so good as to place, at my suggestion, all the patients whom he operated upon, and in whom there was time to use such prophylactic measures, upon doses of muriate of iron given two or three times a day. Dr. Dunsmure has repeatedly assured me, that after adopting this prophylactic measure, his surgical patients seemed to him to recover better, and with fewer threatenings of surgical fever, than at any previous time during his connection with the Hospital. All this might be a coincidence, but Dr. Dunsmure's own impression was that this favourable result was a consequence of the therapeutic measure which he thus employed. Of course a far more extensive experience is required to establish this as a fact; and far more certain and successful prophylactics may be found than the tincture of the muriate of iron. Allow me only further to observe that if the views which I have attempted to give of the pathology of Surgical Fever be in any degree correct, these prophylactics will probably consist of therapeutic means capable of sustaining in their fullest activity the secretory and excretory functions of the system, and thus of keeping the blood itself as free as possible from any over-accumulation within it of unnecessary and effete organic materials. And no doubt the greater accumulation there is of effete matters in the blood at the time when fever happens to be set up in the system by the imbibition of any septic poison, the greater is the peril attending the febrile action. This is true even when the existing effete matter is not the organic material upon which the imbibed zymotic poison specifically acts. Smallpox, for example, scarlatina, and measles, have specific predisposing materials upon which these different poisons severally act—these specific predisposing materials being, as a general law, exhausted in the economy by one attack of these special fevers. But when the poison of any of the diseases which I have just named enters the body of a woman in the puerperal condition, and consequently at a time when her blood is temporarily overcharged with an unusual excess of organic materials in a state of retrograde metamorphosis, in consequence of the rapid absorption of the involving uterus, &c.; then the febrile action which supervenes is usually so extreme in its degree as almost always to prove speedily fatal. Hence, smallpox, scarlatina, and measles, are ten or twenty times more disastrous and dangerous in the puerperal state, than in the common normal state of the system."[1]

In the same Lectures I have endeavoured to show, that in Surgical as in Puerperal Fever, the general constitutional fever and the internal local inflammations do not stand to each other, as was long supposed, in the relation of cause and effect, but are both the effects of one common cause—namely, the special toxæmic state of the blood; and I have attempted to inquire in what mode this toxæmic state was produced in surgical patients, and the pathological mechanism by which it leads on to the internal disseminated inflammatory lesions.

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[1] *Prophylactic surgery.*—See the "Medical Times and Gazette" for May 14, 1859, p. 490.

No. IX.

See Page 452.

ANÆSTHETIC SURGERY: FROM A PATIENT'S POINT OF VIEW.

I HAVE no desire here to enter into any purely professional questions connected with chloroform in operations, nor to look at the subject of Anæsthetic Surgery in any way either as a surgeon or as a physician; but I cannot resist directing the attention of my surgical brethren, for a moment, to the matter of surgical anæsthesia from the patient's point of view; more particularly as it has been so eloquently depicted in a Letter to me in 1856, from one who was so well able to do it—namely, my late most esteemed friend and colleague in the University, Professor George Wilson, who was the subject of a severe surgical operation in 1842, or some years before the introduction of anæsthetics:—

"Several years ago," Professor Wilson writes me, "I was required to prepare, on very short warning, for the loss of a limb by amputation. . . I at once agreed to submit to the operation, but asked a week to prepare for it, not with the slightest expectation that the disease would take a favourable turn in the interval, or that the anticipated horrors of the operation would become less appalling by reflection upon them, but simply because it was so probable that the operation would be followed by a fatal issue, that I wished to prepare for death and what lies beyond it, whilst my faculties were clear and my emotions were comparatively undisturbed, for I knew well, that if the operation were speedily followed by death, I should be in a condition, during the interval, in the last degree unfavourable to making preparation for the great change.

" The week, so slow, and yet so swift in its passage, at length came to an end, and the morning of the operation arrived. . . .

" Before the days of anæsthetics, a patient preparing for an operation was like a condemned criminal preparing for execution. He counted the days till the appointed day came. He counted the hours of that day till the appointed hour came. He listened for the echo on the street of the surgeon's carriage. He watched for his pull at the door bell; for his foot on the stair; for his step in the room; for the production of his dreaded instruments; for his few grave words, and his last preparations before beginning. And then he surrendered his liberty, and revolting at the necessity, submitted to be held or bound, and helplessly gave himself up to the cruel knife. The excitement, disquiet, and exhaustion thus occasioned, could not but greatly aggravate the evil effects of the operation, which fell upon a physical frame predisposed to magnify, not to repel, its severity. To make a patient incognizant of the surgeon's proceedings, and unable to recal the details of an operation, is assuredly to save him from much present and much future self-torture, and to give to him thereby a much greater likelihood of recovery. . . .

"The operation was a more tedious one than some which involve much greater mutilation. It necessitated cruel cutting through inflamed and morbidly sensitive parts, and could not be despatched by a few swift strokes of the knife. I do not suppose that it was more painful than the majority of severe surgical operations are, but I am not, I believe, mistaken in thinking that it was not less painful, and this is all that I wish to contend for.

"Of the agony it occasioned I will say nothing. Suffering so great as I underwent cannot be expressed in words, and thus fortunately cannot be recalled. The particular pangs are now forgotten; but the black whirlwind of emotion, the horror of great darkness, and the sense of desertion by God and man, bordering close upon despair, which swept through my mind and overwhelmed my heart, I can never forget, however gladly I would do so. . . .

"During the operation, in spite of the pain it occasioned, my senses were preternaturally acute, as I have been told they generally are in patients in such circumstances. I watched all that the surgeons did with a fascinated intensity. I still recal with unwelcome vividness the spreading out of the instruments; the twisting of the tourniquet; the first incision; the fingering of the sawed bone; the sponge pressed on the flap; the tying of the blood-vessels; the stitching of the skin; and the bloody dismembered limb lying on the floor.

"Those are not pleasant remembrances. For a long time they haunted me, and even now they are easily resuscitated; and though they cannot bring back the suffering attending the events which gave them a place in my memory, they can occasion a suffering of their own, and be the cause of a disquiet which favours neither mental nor bodily health. From memories of this kind, those subjects of operations who receive chloroform are of course free; and could I, even *now*, by some Lethean draught, erase the remembrances I speak of, I would drink it, for they are easily brought back, and they are never welcome. . . .

"I plead, therefore, for the administration of anæsthetics. I fear you may think my confessions exaggerated, but I can most honestly declare that they are not. When I first heard that anæsthetics had been discovered, I could not and would not believe it. I have since thanked God many a time, that he has put it into your heart, and into that of other wise and humane men, to devise so simple and so safe a way of lessening pain." . . .[1]

After perusing such a touching and terrible account of what surgical patients were sometimes called upon to suffer, before the introduction of modern anæsthetics, it is delightful to reflect, that in despite of M. Velpeau's prophecy to the contrary, all these forms of surgical human agony are essentially ended and abrogated. We now know also and acknowledge, that these tortures—so long endured as dire and dreadful necessities—were of no advantage, but the very reverse, to the patient himself. For assuredly, in accordance with the old maxim of Galen, "*dolor in dolentibus inutilis est.*" And at the present hour any deliberate and causeless infliction on a fellow-being of such sufferings as Professor Wilson so pathetically describes, amounts to nothing but professional inhumanity, for on the part of professional men "the infliction of all unnecessary pain is simple cruelty." Whilst anæsthetics save the patient from the agonies produced by the mutilation and cutting of his living flesh, they at the same time preserve his strength, and enhance his chances of recovery. But surgical anæsthetics are not a boon merely to the surgical patient; they are a boon also to the surgeon himself—as they enable him to accomplish his knife-work far more calmly and deliberately; and they give him the power of operating in cases and under circumstances, where previously operative interference was almost impossible. Professor Marx of Göttingen, writing in a more hopeful spirit than Professor Velpeau, long since avowed his belief that, in regard to the possible mitigation of surgical pain, "the multiplied experiments to prevent pain in surgical operations, which bear so delightful a testimony to the humanity of their authors, will certainly in the course of time be crowned with success."[1] And it is pleasant to reflect with what celerity the practice has spread over the surface of the earth. In Great Britain there are various establishments for the manufacture of chloroform. I know of one—that of Messrs.

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[1] *Professor Wilson's letter.*—See the letter in full in my "Obstetric Memoirs and Contributions," vol. ii. p. 796.

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[1] *Marx.*—See his letter to Herman Boerhaave, in his "Akesios," Dr Macness's translation, p. 329.

Duncan, Flockhart, and Company, of Edinburgh—where, every day, as many as 4000 doses of chloroform are regularly made; and I have heard of others, in our own country, and on the continents of Europe and America, where the manufacture of this drug is carried on every day to the extent of many thousands more. Much human anguish is already daily abrogated by this daily expenditure of chloroform; and the amount of suffering saved, and the amount of chloroform used, goes on from year to year rapidly increasing.

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